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AMERICAN MACHINIST

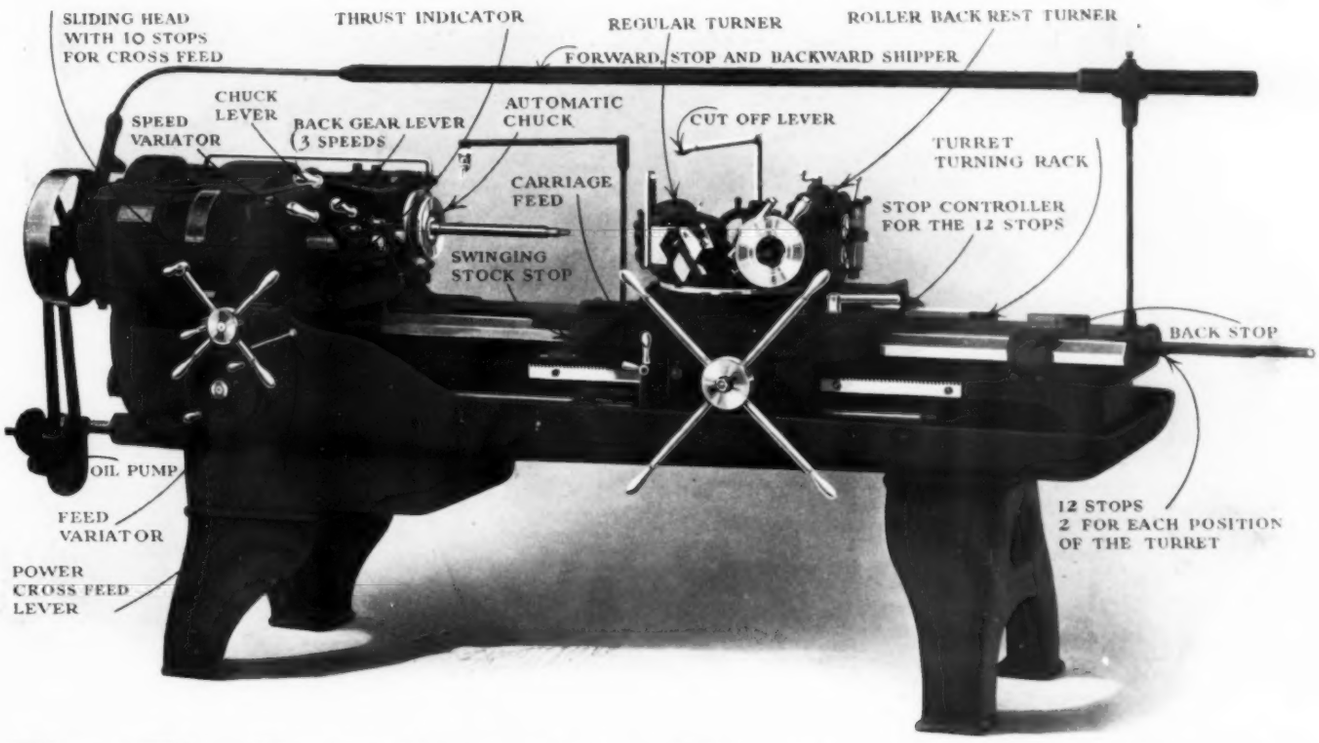
A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

505 PEARL STREET, NEW YORK.

Vol 29. No 52.

Index to Advertisers and Classified Index Following Reading Matter.



The "Flat Turret" Lathe Is The Stockholder's Friend

Because it makes duplicate parts 50% to 80% cheaper than is possible on an engine lathe—handles all bar or chuck work without requiring special tools—produces exactly uniform parts, thus greatly reducing assembling expenses, facilitating output and increasing the efficiency of finished machines. In these and other ways it tends to increase the stockholder's dividends. You can have positive proof of this at our expense.

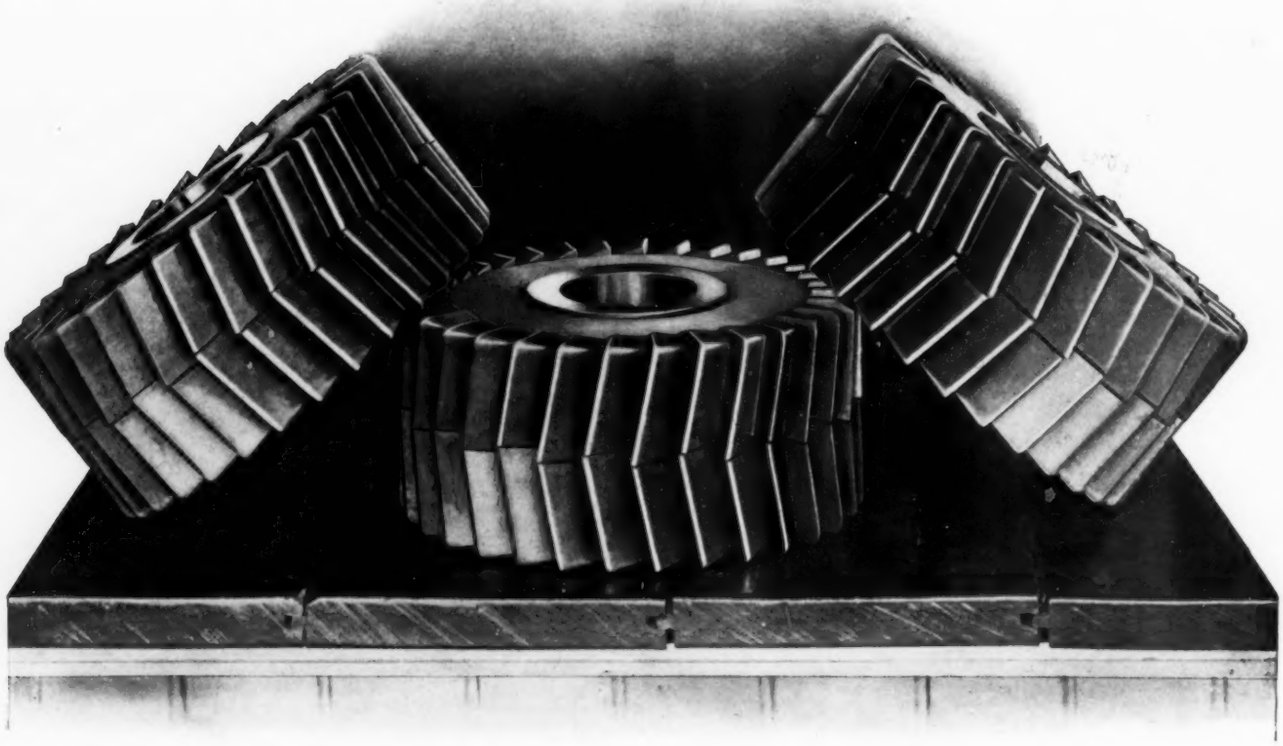
JONES & LAMSON MACHINE COMPANY

Springfield, Vt., U. S. A., and 97 Queen Victoria St., London, E. C.

MACHINISTS' SMALL TOOLS

INTERLOCKING MILLING CUTTERS

are made in halves, the teeth of one half interlocking with other. The width may be kept constant by placing washers between the two halves after cutters are ground.



Taps, Dies, Reamers, Ratchet Drills, Die Stock Sets, Taper Pins, Boiler Punches, Lathe Tools, Standards, Gauges, Etc., of the highest grade obtainable.

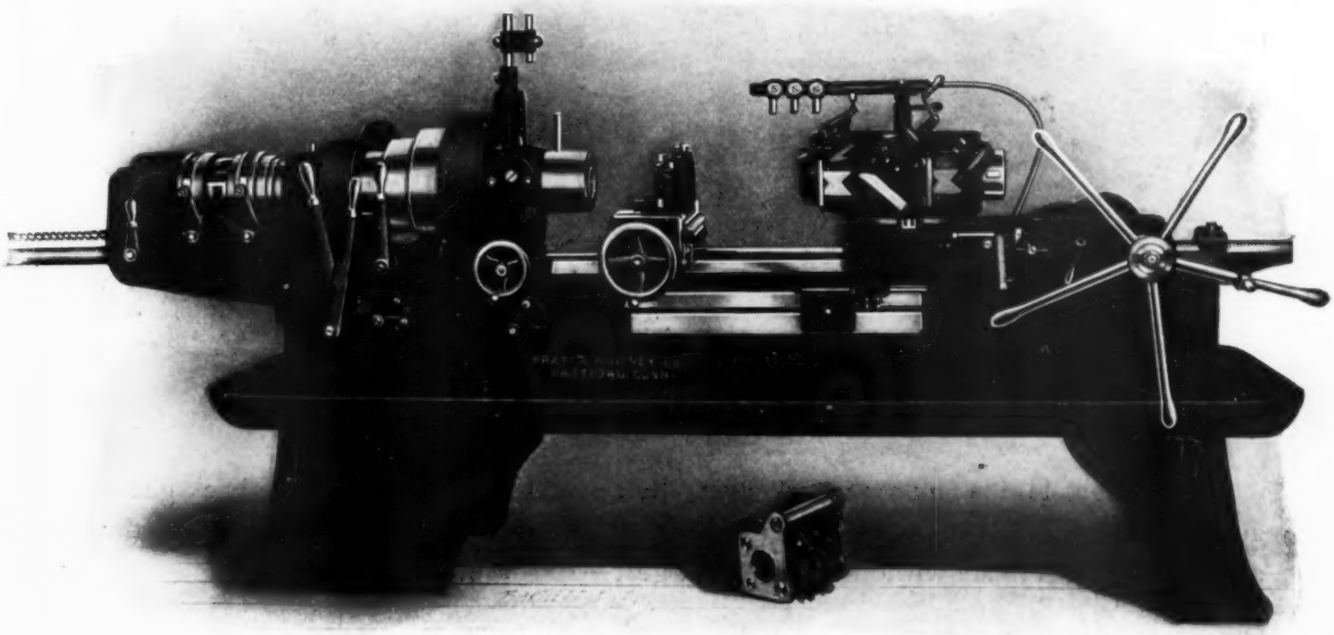
PRATT & WHITNEY COMPANY,
HARTFORD, CONN., U.S.A.

OFFICES—**Trinity Building, 111 Broadway, New York.** Boston: Oliver Bldg. Chicago: 46 South Canal St. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver.

TURRET LATHES

Regularly Built in Five Sizes

⅝ x 4½" 1 x 10" 1½ x 18" 2 x 26" 3 x 36"



3 x 36 inch Turret Lathe.

A particular feature of this machine is the chuck-closing mechanism which admits stock 1-16 over size to 1-32 under size to be clamped with a uniform pressure without readjustment of chuck.

Independent turret stops, simple and easy to change, are provided for each tool on the turret.

The turret tools are rigid, being firmly supported by the broad faces of the turret, and are easily put in place.

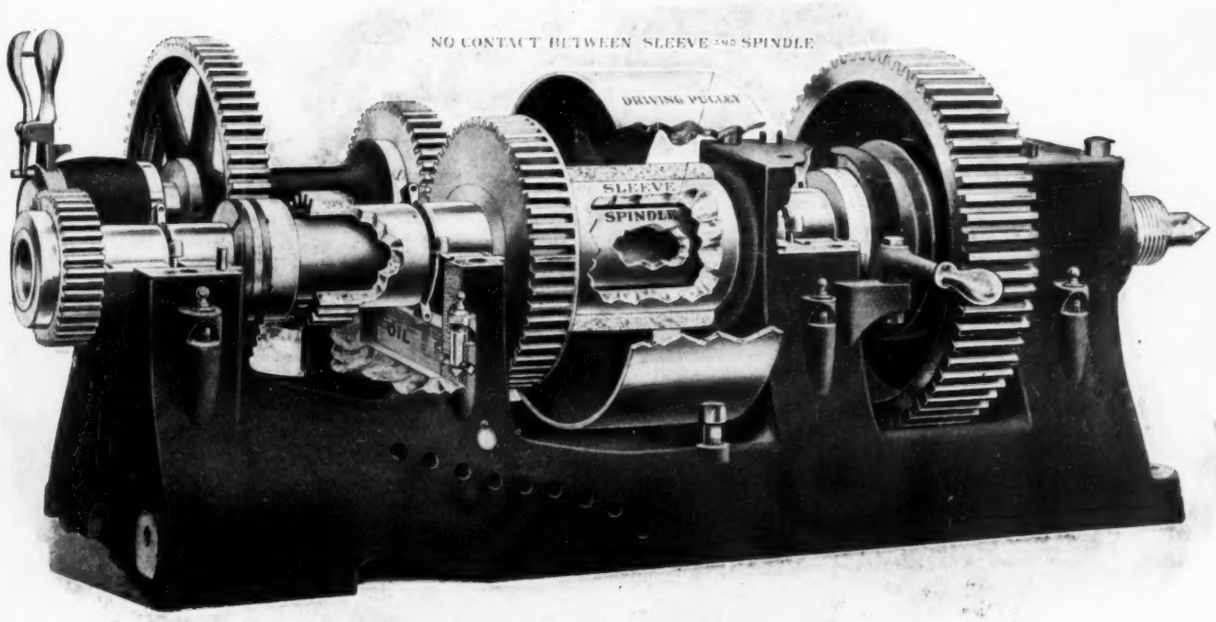
The cross slide enables facing, forming and boring operations to be carried on at the same time.

Illustrated circulars, "Turret Lathes", covering five sizes, sent on request.

PRATT & WHITNEY COMPANY,

HARTFORD, CONN., U.S.A.

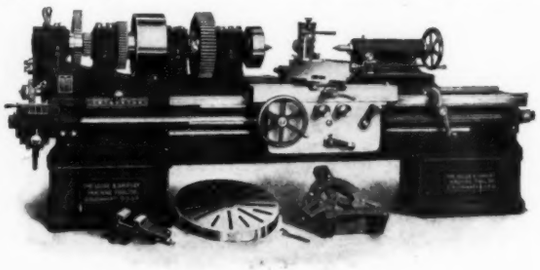
OFFICES—Trinity Building, 111 Broadway, New York, Boston: Oliver Bldg. Chicago: 46 South Canal St. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver.



24" Patent Headstock for 6½" Driving Belt over 15⅝" Pulley double back geared—automatically oiled spindle, sleeve and back gear bearings (ring oilers shown) 32 thread and feed changes made without removing a gear—18 speeds.

No Belt Pull On Spindle

When you stop and figure out the Patent Headstock and *find* the power is applied to a wide faced pulley of large diameter, which is keyed to a sleeve revolving in the two central bearings of headstock, and that the lathe spindle passes thru this sleeve without touching it, having a clearance of an eighth of an inch and revolves in the two outer bearings, *you realize* that there are power possibilities far beyond anything before attempted on a lathe drive, as well as longer lathe life.

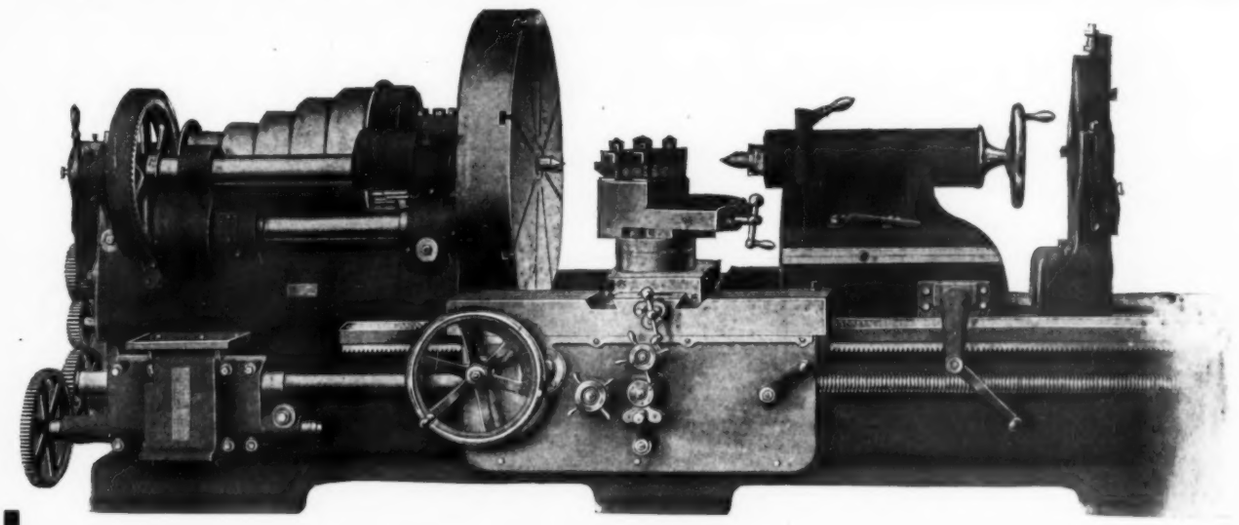


24" Patent Head Engine Lathe.

The Lodge & Shipley Machine Tool Company

CINCINNATI, OHIO, U. S. A.

CANADIAN AGENT—H. W. Petrie, Toronto.
EUROPEAN AGENTS—Alfred H. Schütte, Cologne, Paris, Brussels, Barcelona, Milan; C. W. Burton, Griffiths & Co., London; V. Loewener, Copenhagen, Stockholm, Christiania; R. S. Stokvis & Zonen, Rotterdam; Schuchardt & Schütte, Berlin, Vienna, St. Petersburg; Werner Hult, Helsingfors, Finland.
OTHER AGENTS—Bevan & Edwards, Melbourne, Australia; Richardson & Blair, Wellington, New Zealand; Adolfo B. Horn, Havana; W. F. Mackenzie, Mexico City; Andrews & George, Yokohama.



Provided with a Substantial Rapid Feed Change and Coarse Thread Cutting Mechanism

This Bradford 42-inch Triple-Geared Lathe fills the exact needs of general manufacturing. It enables the handling of work with ease and rapidity, yet it is powerful and rigid enough to withstand all the strain that it's likely to receive through severe high speed steel service. ¶ A powerful carriage, with long bearings on ways, is used in connection with a double apron, having non-interfering feed reverse; so that no two feeds may engage simultaneously. Compound rest has both cross and angular feeds. Fifteen spindle speeds can be had with three rigid feed changes for each speed without the removal of a gear.

The Bradford Machine Tool Company

CINCINNATI -:- **OHIO, U. S. A.**

Vandyck Churchill Co., New York and Philadelphia, Eastern Agents. Pacific Tool & Supply Co., San Francisco, Cal., **Agents** for Pacific Coast.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow, Newcastle-on-Tyne. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. F. W. Horne, Japan, China and Far East.

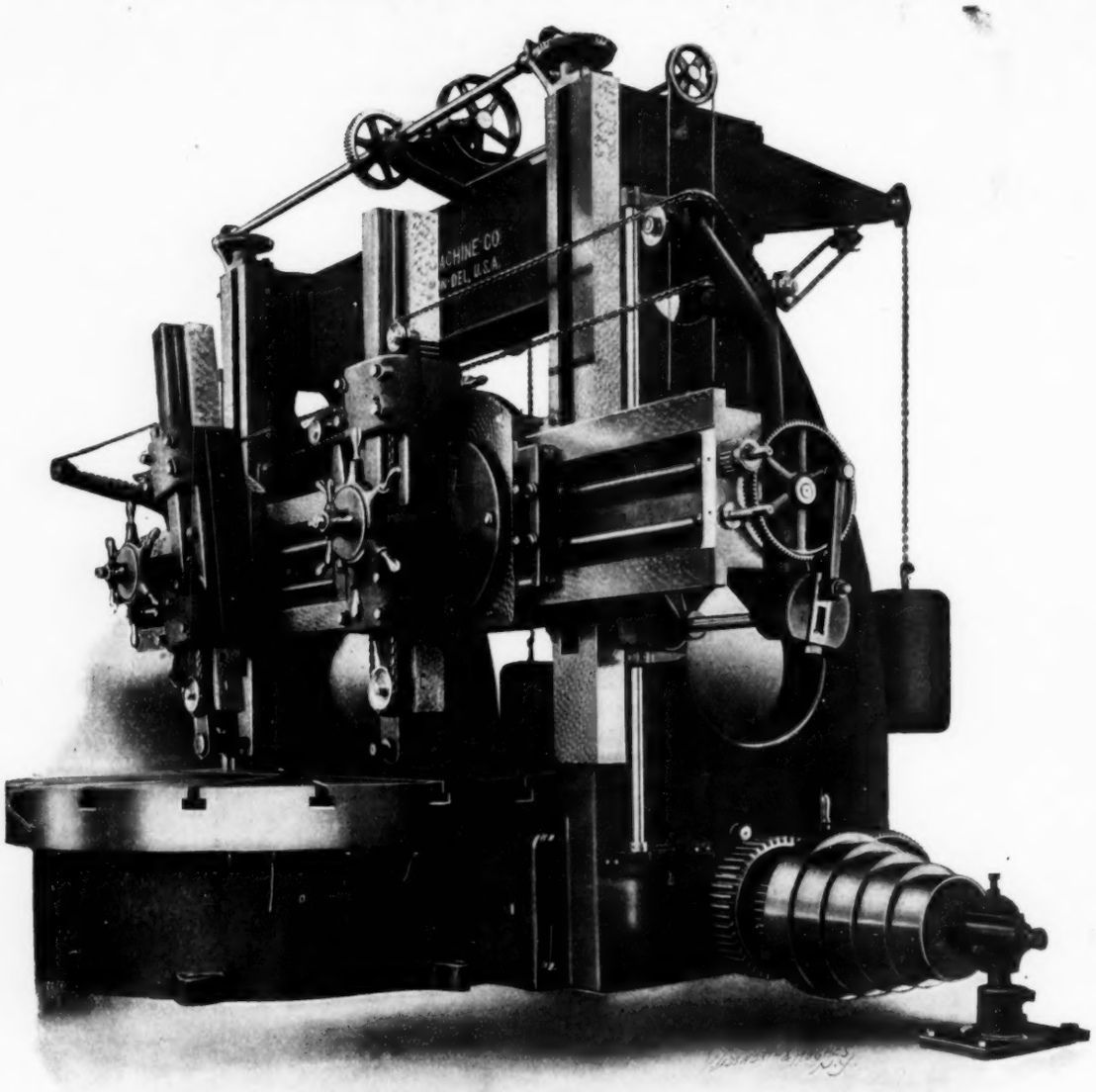
BETTS MACHINE COMPANY

WILMINGTON, DELAWARE, U. S. A.

MAKERS OF

HEAVY MACHINE TOOLS

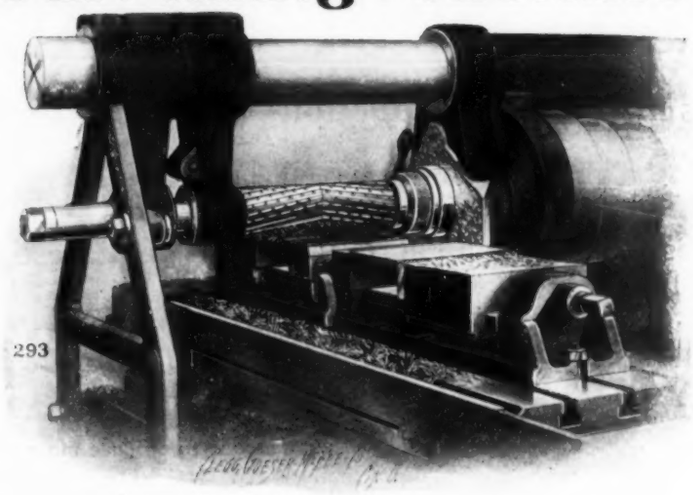
FOR HIGH SPEED STEEL



New Design BETTS 8 Ft. Boring and Turning Mill

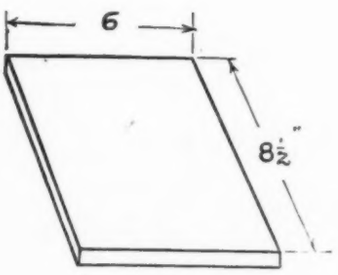
Vertical Boring Mills, Planers, Horizontal Boring Machines, Slotters, Etc.

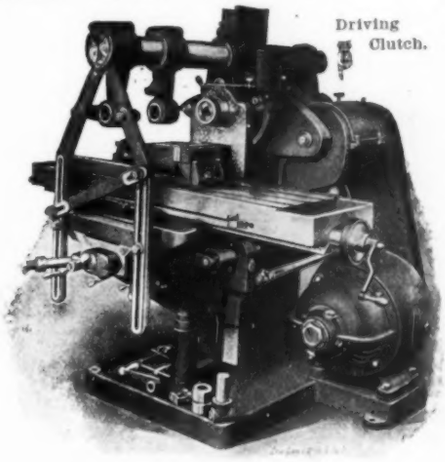
The Ideal Milling Machine Drive



No. 4 PLAIN MOTOR-DRIVEN MILLER.

Grey iron castings 8½" wide, cut $\frac{3}{32}$" deep, cutter 4" diam., High Speed Steel, 60 r. p. m., feed .250", table travel 15" per minute.





"The Ideal Drive."

Our No. 4 Plain motor-driven Miller takes a roughing cut across these pieces at a table travel of 15" per minute. The same size machine belt-driven, does it at a table travel of 12" per minute. That's good work for the belt-driven machine, but the motor drive beats it by 25%. It is because the drive is positive, has no slipping belts, and always delivers the maximum power.

It doesn't pay to install belt-driven machines. **Let us tell you all about our Motor-Driven Millers.**

WE ARE MILLING SPECIALISTS.

The Cincinnati Milling Machine Co.,

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADIAN AGENTS—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

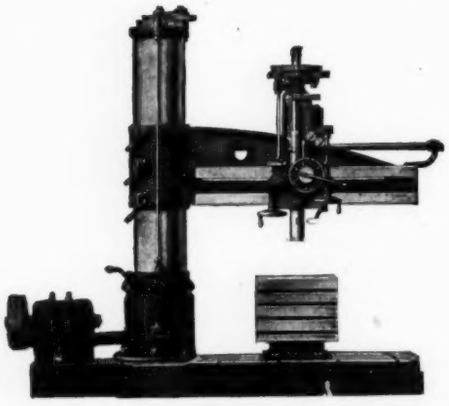
MODERN SHOP PRACTICE

Demands Increased Production==Accuracy==Reliability.

We Will Deliver

To any responsible manufacturer one of our Latest Design

"American" Plain Radials



and will guarantee it to produce more work than any other similar sized Radial Drill on the market, without exception.

Our New "AMERICAN" Radial
HAS BROKEN ALL KNOWN RECORDS
FOR **RAPID DRILLING.**

We back our confidence to the above extent

Sizes: 2½-ft., 3-ft., 3½-ft., 4-ft., 5-ft., 6-ft., 7-ft. Arms

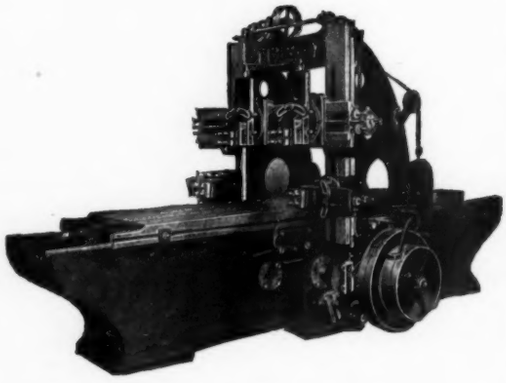
---

STANDARD Single or Variable Speed WIDENED

Planers

of sufficient strength and weight to obtain the very best results in planing with high-speed steels. Our New Pattern Planers operate in our own shops at cutting speeds from 40 feet to 70 feet per minute.
Their Extraordinary Power, the Accuracy of their Alignments and the extreme Smoothness of their operation insure the very highest Quality of work throughout.

Sizes: 22 inches to 72 inches between Housings.

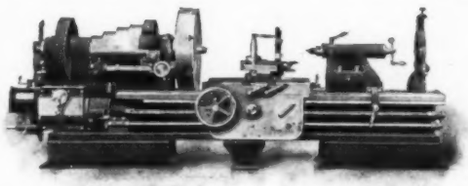


The American Tool Works Co.

Cincinnati, U. S. A.

LATHES, PLANERS, SHAPERS, UPRIGHT and RADIAL DRILLS

Thirty-Two Inch Triple Geared Instantaneous Change Gear Engine Lathe.



All Changes of Feeds and Screw Cutting Made Without Removal of a Gear.
Reverse Feed in the Head for Both Feeds and Screw Cutting.
Power Cross Feed.
Reverse in the Apron for Feeds.

SCHUMACHER & BOYE, Engine Lathes, 18" to 48" Swing. **Cincinnati, Ohio, U. S. A.**

Ph. Bonvillain & E. Ronceray, 9 & 11 Rue des envierges, Paris. Buck & Hickman, Ltd., 2 and 4 Whitechapel Road, London, E., England. Ludwig Loewe & Co., 17-20 Huttenstrasse, Berlin, Germany. Takata & Co., Tokio, Japan.

THE STANDARD TOOL CO'S Oil Tube Twist Drills

Furnished with either Taper or Straight Shanks. These tools are time-savers.
The oil keeps the cutting edges cool and forces out the chips.
Write us.

OFFICE and FACTORY, CLEVELAND, O. EASTERN SALESROOM, 94 READE ST., N. Y.

LONDON—C. W. Burton, Griffiths & Co. PARIS—Burton Fils. GENEVE—J. Lambercier & Cie.

STANDARD TOOL CO.

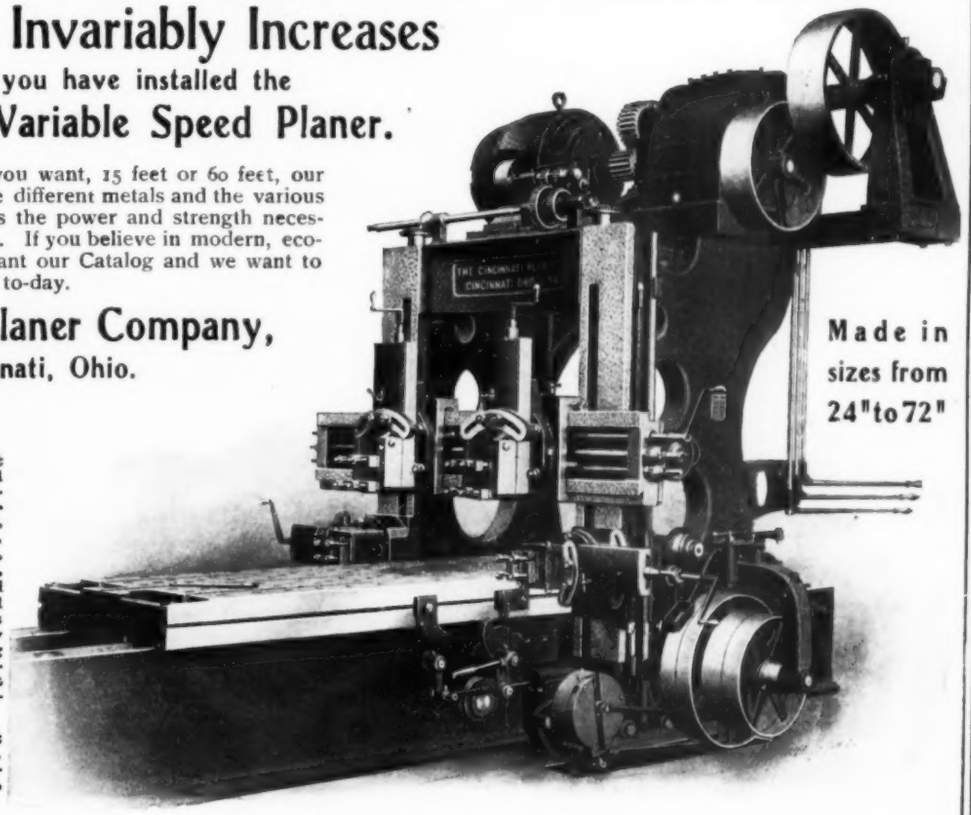
Production Invariably Increases

when you have installed the

Cincinnati Variable Speed Planer.

No matter what speed you want, 15 feet or 60 feet, our Planer has it. It suits the different metals and the various stages of the work and has the power and strength necessary for the higher speeds. If you believe in modern, economical methods, you want our Catalog and we want to send it. Drop us a postal to-day.

Cincinnati Planer Company,
Cincinnati, Ohio.



Made in sizes from 24" to 72"

DOMESTIC AGENTS—Prentiss Tool & Supply Co., New York, Boston and Buffalo. Marshall & Huschart Machinery Co., Chicago. Motch & Merryweather Machinery Co., Cleveland, Ohio. W. E. Shipley, Philadelphia, Pa. Baird Machinery Co., Pittsburg, Pa. W. R. Colcord Machinery Co., St. Louis, Mo. Scott Supply & Tool Co., Denver, Colo. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Hallidie Machinery Co., Seattle. Cotton States Belting & Supply Co., Atlanta. The Fairbanks Co., Baltimore. Vonnegut Hardware Co., Indianapolis. Robinson & Cary Co., St. Paul.

FOREIGN AGENTS—Ludw. Loewe & Co., Berlin. Vaghi, Accornero & Co., Milan R. S. Stokvis & Zonen, Rotterdam, Holland. J. Lambercier, & Co., Geneva, Switzerland.

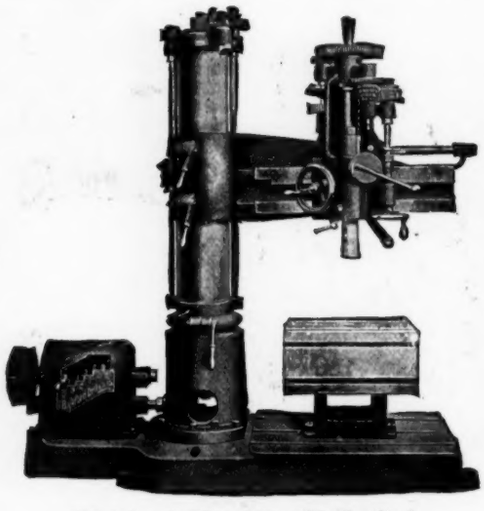
EVERY FEATURE AND THEN SOME——

This 30" Bickford Radial embodies every feature of advantage found in a large Upright Drill and then some.

The drill is admirably adapted to light and medium manufacturing, and has been designed to meet the requirements of such ordinary work as is found in the average shops.

There are 12 speeds when the machine is fitted with a gear box, and 10 when fitted with a cone.

The feeds under 4 "are positive" and can be instantly engaged while the machine is running.



Bickford 30", 36", 42" Radial.

Tapping attachment is embodied in the design of the head.

Remember, the machine is built in three sizes 30", 36" and 42" Arm.

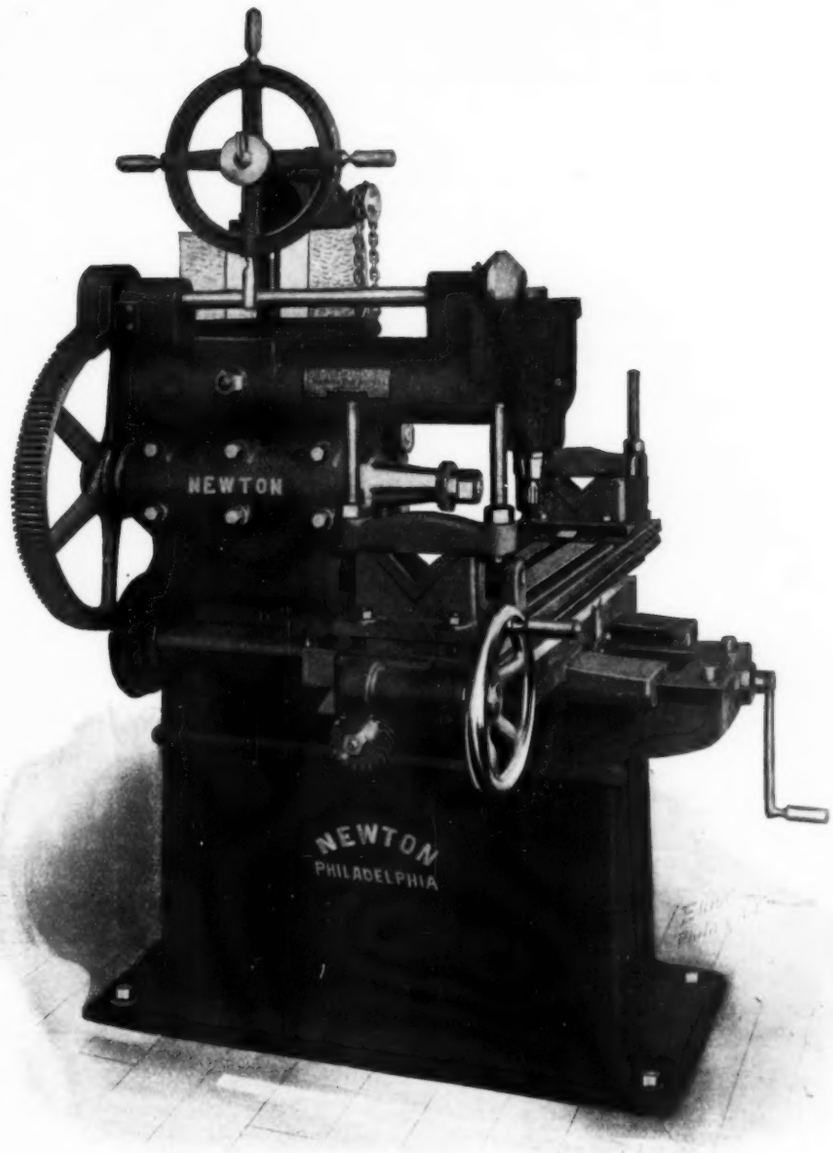
Circular 1-A, shall we send it?

THE BICKFORD DRILL AND TOOL CO.
CINCINNATI, OHIO, U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, New York. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano, Bilbao, New York. Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. H. W. Petrie, Toronto, Canada. Williams & Wilson, Montreal, Canada.

A 4

NEWTON



No. 2 Keyseating Milling Machines.

The above machines are built in two sizes, having a capacity for shafts 4 in. and 8 in in diameter and keyseats 24 in. and 30 in. length.

NEWTON MACHINE TOOL WORKS, INC.

PHILADELPHIA, PA., U. S. A.

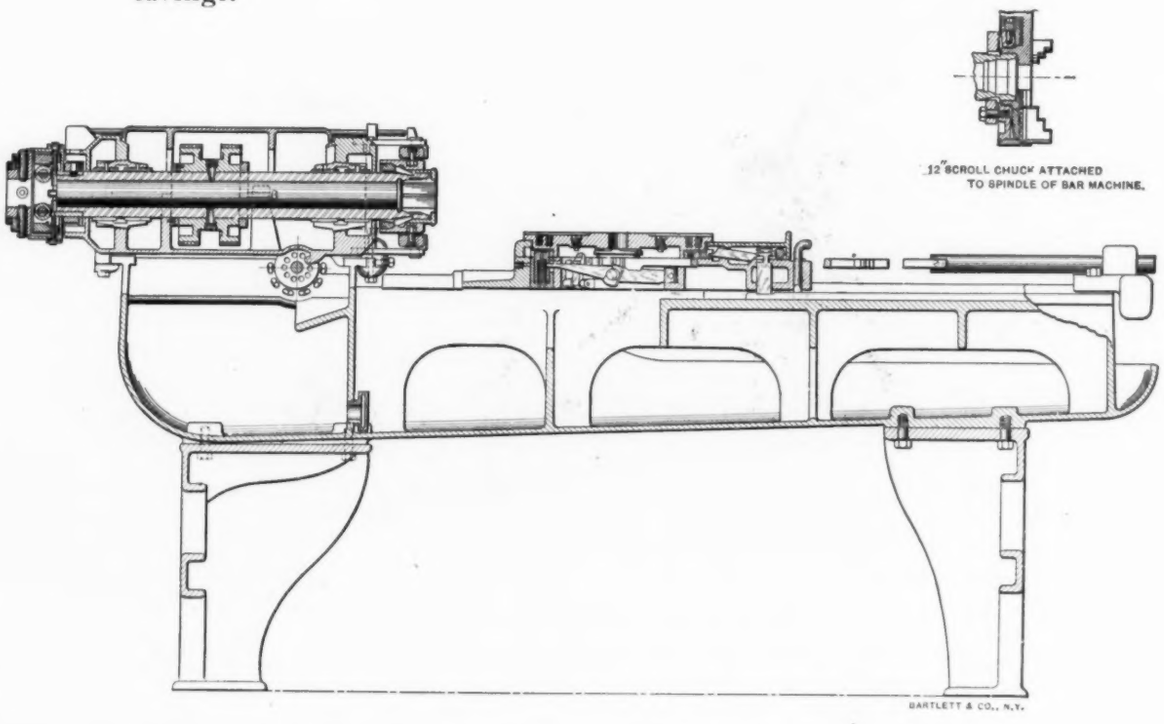
The Cautious And The Impetuous Business Man Are Both Satisfied

with the earnings which accrue, day by day, through the use of the "Flat Turret" Lathe, because it comes up fully to the expectations of each.

And it is not a machine that it is necessary to have a long time in the place before it will effect certain savings.

Each day's setting sun finds a good big saving on work, which has heretofore been done on the engine lathes, while at the final assembling it is found that not only has a saving been effected on the first cost, but on the total cost as well.

By sending a man to your place to go over your conditions, we are enabled to actually give you a specific guarantee, which will absolutely bind the "Flat Turret" to positively effect certain savings.



Jones & Lamson

Springfield, Vt., U. S. A., and 97 Queen Victoria St., London, E. C.

With The "FLAT TURRET" Lathe

you are enabled to turn out more work, per square foot of floor space and dollar invested, than you are now doing.

Here's just a point or two:

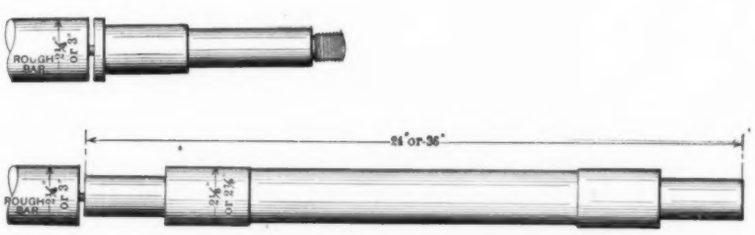
It's the **ONLY** "Flat Turret" Lathe.

Has a cross-sliding Headstock, providing a cross feed for every tool and a double stop for each position of the turret.

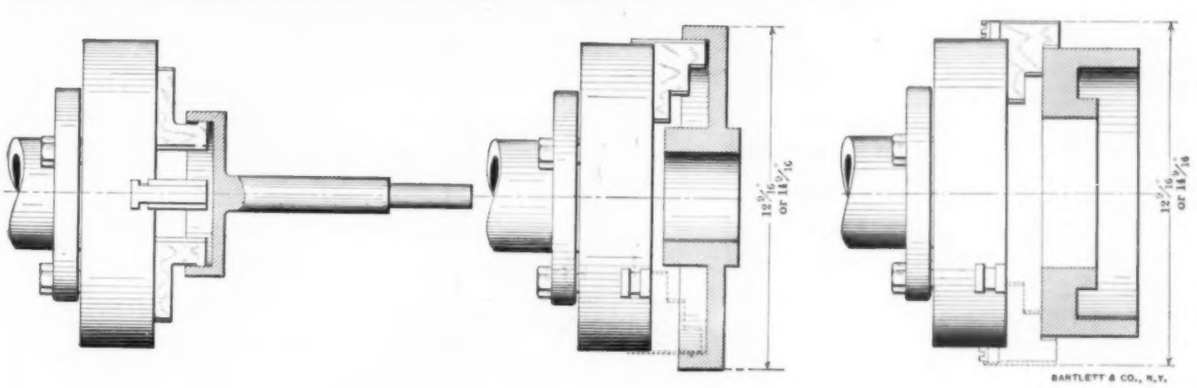
Has a complete tool equipment for either Bar or Chuck work and the turret turns automatically to the position wanted.

In presenting to you the advantages to be derived from a "Flat Turret," we assume the position you stand in is one of incredulity and we make it a part of our selling plan to **SHOW** and to **ABSOLUTELY CONVINCE** you. And the only actual cost to you is the two cents necessary to open up communication with us.

Will you invest today?



Examples indicating working range and character of work covered by the two sizes of the "Flat Turret" Lathes.



Machine Company

Germany, Holland, Belgium, Switzerland and Austria-Hungary: M. Koyemann, Charlottenstrasse, 112, Düsseldorf, Germany. France and Spain: Ph. Bonvillain and E. Ronceray, 9 and 11, Rue des envierges, Paris. Italy: Adler & Eisenschitz, Milan.

Adjustable Screw Press

Quick Work Strong Practical

TRADE W.F. J.G. MARK

Built in Three Sizes
20 to 50 Tons Capacity

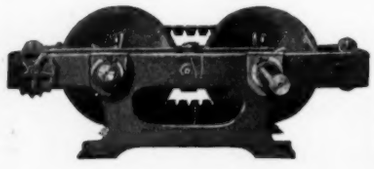
Pulleys and Gear Wheels pressed on Shafts by this machine are more securely fixed and less liable to be out of true.

If you are interested in modern methods of doing work in the machine shop, send for our Catalog, which describes more fully the practical points of this tool.

W. F. & Jno. Barnes Co.

ESTABLISHED 1872.

1995 Ruby Street Rockford, Ill.



Speed Transmission Troubles ?

You have them, if you are still plodding along with the Cone Pulley. You are losing money, too.

It is the speed half-way between the steps of a cone pulley that you ought to have in nine out of ten cases, in order to realize **all** of the **profit** that's coming.

Reeves Variable Speed Transmission will give you **just the speed** you are after. **Today** is the time to look it up.

Reeves Pulley Co.,

COLUMBUS, INDIANA.

Foreign Representatives: Charles Churchill & Co., London, E. C. Chavenne-Brun Freres, St. Chamond, France. H. Fullner, Warmbrunn, Germany, Licensed Manufacturer.

We also make fuel gas plants

Save Money On Forging.

If you want a cheap, quick, clean way of forging and tempering small tools or bars up to 2" x 2" x 6", you should have

Gas Forge No. 2.

With it you have full control of the heat always--any temperature --any time. It is a most efficient, durable and economical machine.

Let us prove it.

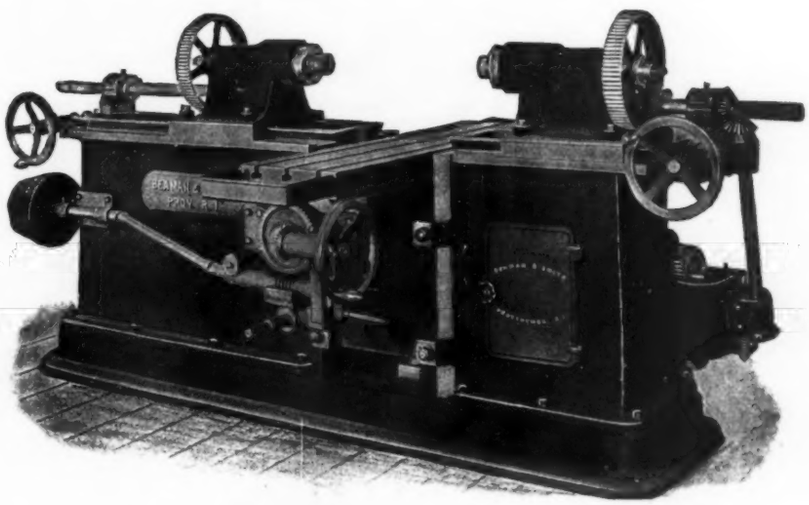
For description get "High Speed Steel Supplement No. 2."

American Gas Furnace Co.

23 John Street, New York.

Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg. H. Glaenser & Perraud, Paris.

We Construct Many Kinds Of Machine Tools



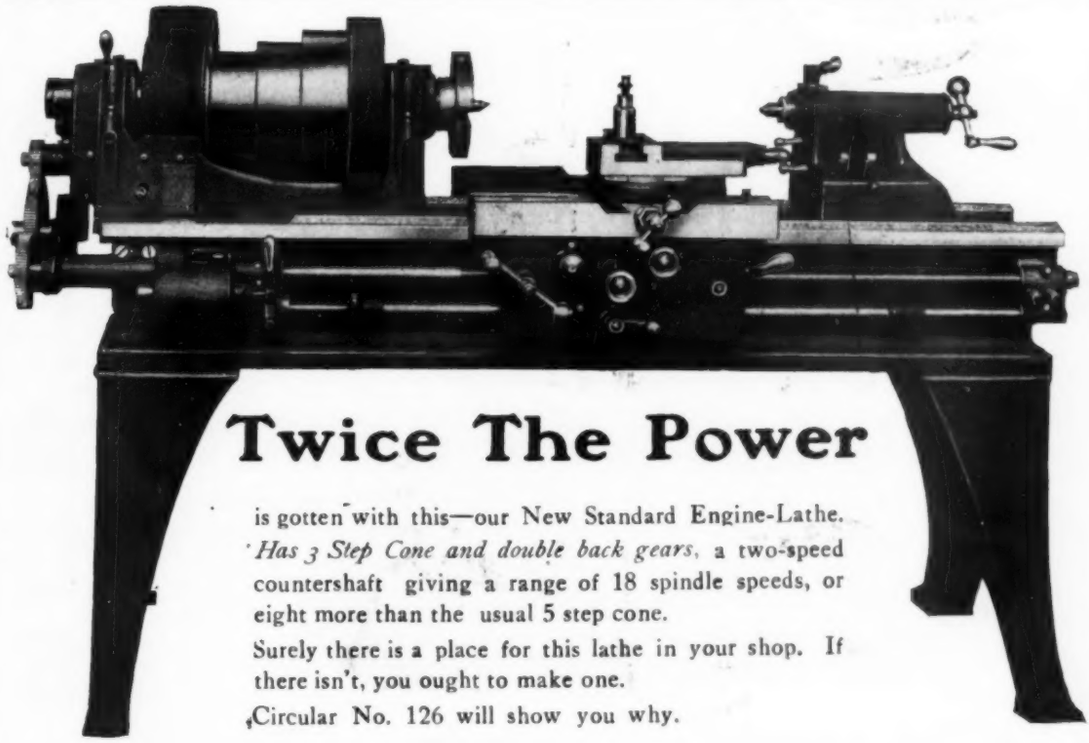
Our Specialty Is Boring and Milling Machines

Our No. 2 Duplex Milling Machine

A very useful tool—takes two cuts at once, has a wide range of adjustment and large capacity.

THE BEAMAN & SMITH CO., PROVIDENCE, R. I.

Germany: Ludw. Loewe & Co., Berlin, England: Chas. Churchill & Co., London. France: Fenwick Freres & Co., Paris.



Twice The Power

is gotten with this—our New Standard Engine-Lathe. *Has 3 Step Cone and double back gears*, a two-speed countershaft giving a range of 18 spindle speeds, or eight more than the usual 5 step cone.

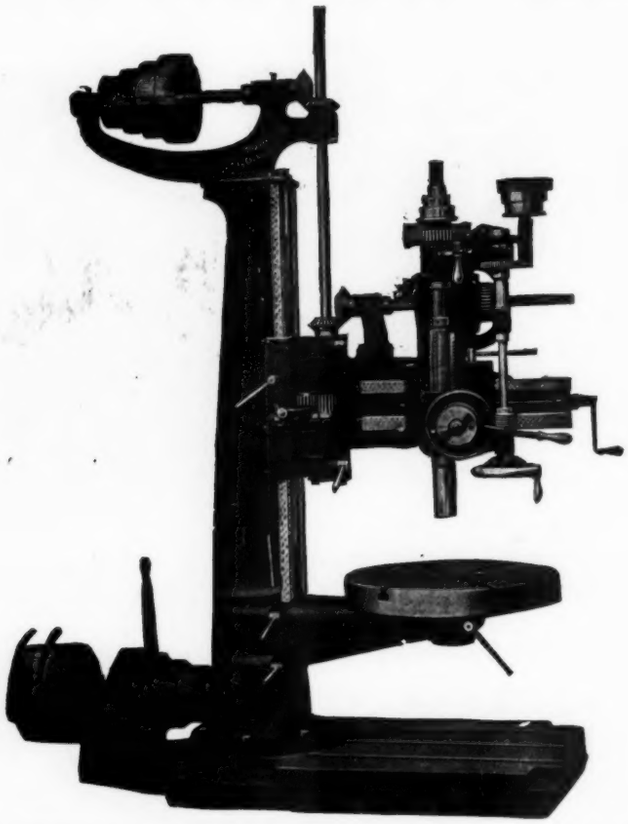
Surely there is a place for this lathe in your shop. If there isn't, you ought to make one.

Circular No. 126 will show you why.

The Springfield Machine Tool Co., SPRINGFIELD, OHIO, U. S. A.

Ing. Vaghi Accornero & Co., Agents for Italy.

FOSDICK



National Radial Drills with
2-2½-3-4 and 5 foot arms.

RADIALS

THE FOSDICK MACHINE TOOL COMPANY, Cincinnati, Ohio, U. S. A.

AGENTS—C. W. Burton, Griffiths & Co., London, E. C. Fenwick Freres & Co., Paris, France; Liege, Belgium; Zurich, Switzerland; Milan, Italy. Ludw. Loewe & Co., Berlin, Germany. R. S. Stokvis & Zonen, Rotterdam, Holland. Hugo Tillquists, Stockholm, Sweden. Adolfo B. Horn, Havana, Cuba. A. R. Williams Machinery Co., Ltd., Toronto, Ont., Canada. McDowell, Stocker & Co., Chicago, Ill. J. W. Wright & Co., St. Louis, Mo. Bailey-Smith Machinery Co., San Francisco, Cal. L. Booth & Sons, Los Angeles, Cal. The Caldwell Bros. Co., Seattle, Wash. C. C. Wormer Machinery Co., Detroit, Mich. W. M. Pattison Supply Co., Cleveland, Ohio. The E. A. Kinsey Co., Cincinnati, Ohio. Somers, Fitler & Todd Co., Pittsburg, Pa. The Fairbanks Co., Philadelphia.

NICHOLSON

UNEXCELLED IN CUTTING POWER, DURABILITY, UNIFORMITY.

BEST VALUE OFFERED BY ANY FILE MAKERS IN THE WORLD.

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CATALOGUE AND "FILE PHILOSOPHY" ON REQUEST.

CARRIED IN STOCK BY LEADING DEALERS IN EVERY TRADE CENTER OF THE WORLD.

FILES

BETTER TAPS

than **CARD'S** cannot be made—if they could we'd be making them and they'd still be **CARD'S.**

Do you want long life, accurate service and keen cutting power in Taps? If you do the answer is **CARD TAPS.** Catalog?

S. W. CARD MANUFACTURING COMPANY,
MANSFIELD, MASS., U. S. A.
New York Store, 123 Liberty St. Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow.

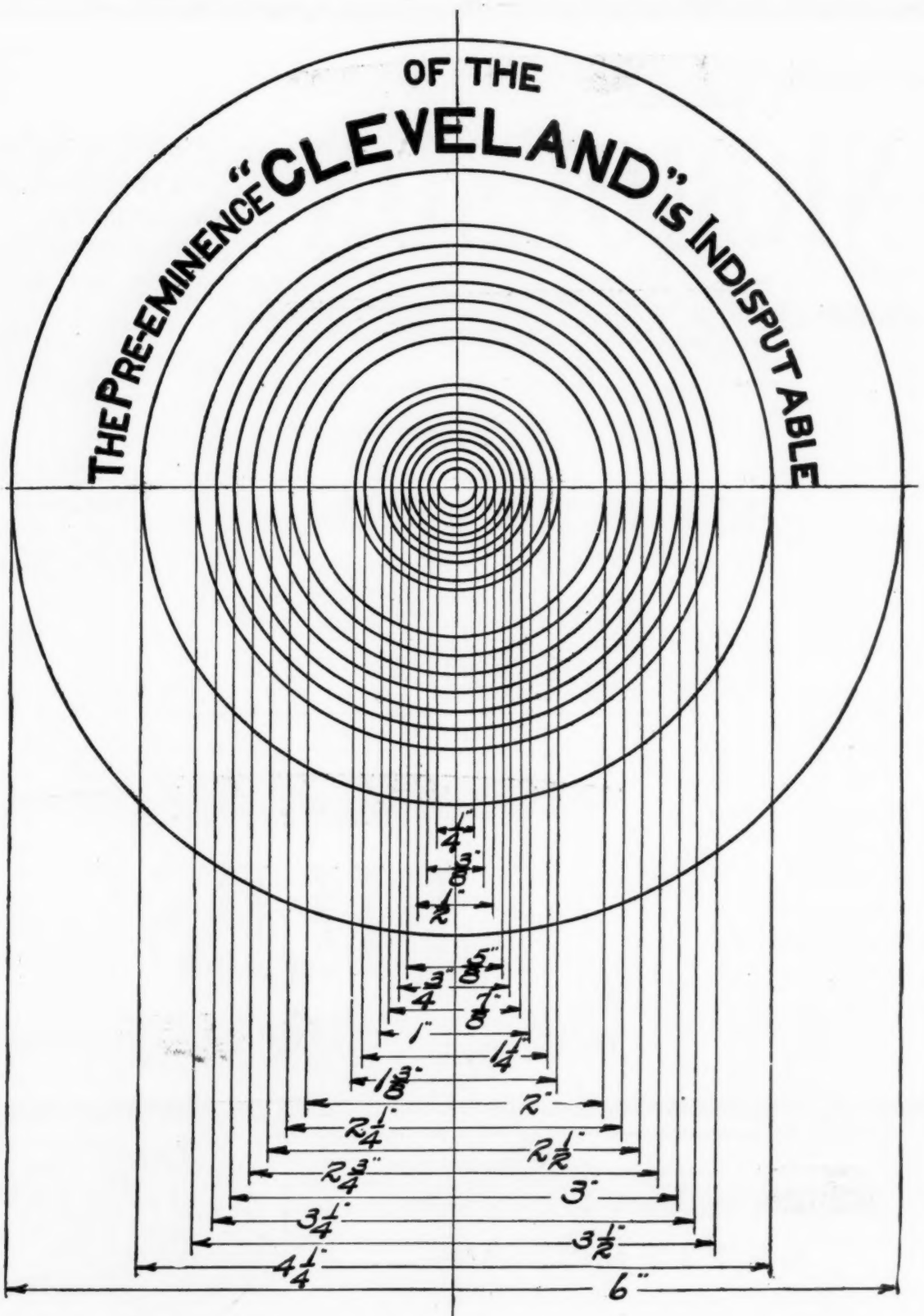
The Slightest Variation Of Pressure

In a steam boiler or other receptacle is accurately recorded on the chart of the

Crosby Pressure Recorder

which works night and day whether you're there or not. You don't have to watch it. Its use has effected many savings in steam boiler plants. Get the Crosby.

Crosby Steam Gage & Valve Co.
Office and Works, Boston, Mass.
93-97 Oliver St., Boston, Mass. 74 John St., New York. 21-23 W. Lake St., Chicago. 147 Queen Victoria St., London.

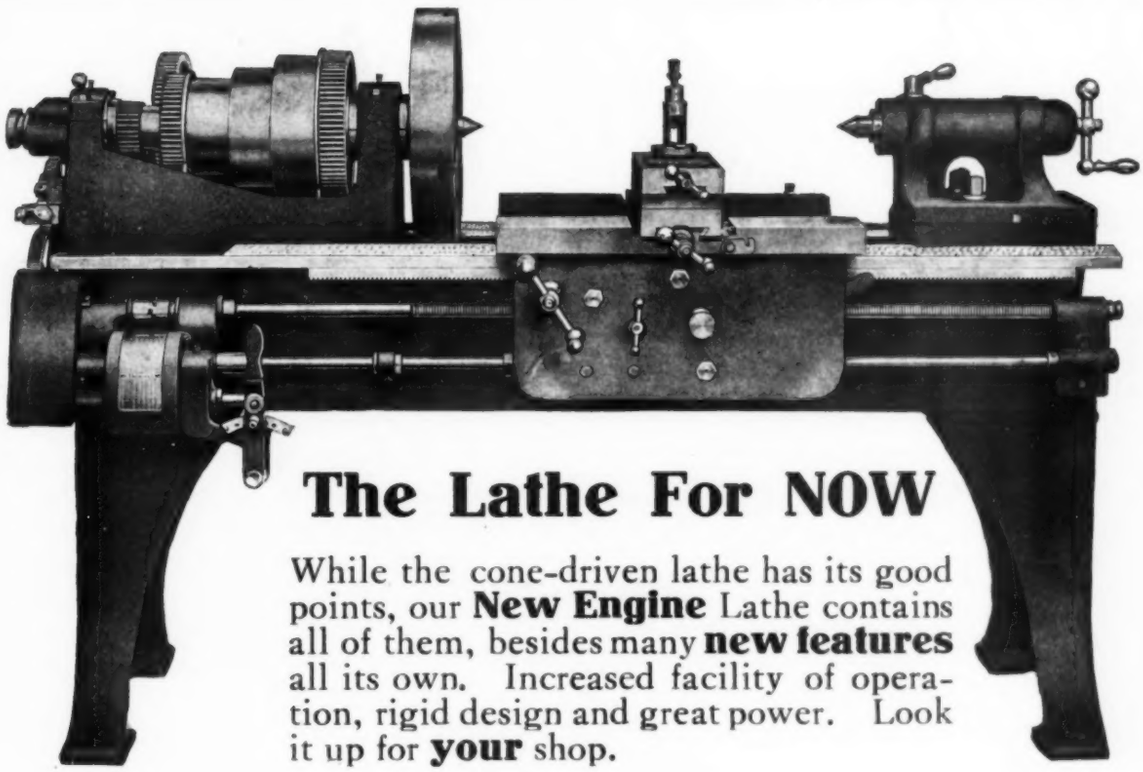


Each circle represents the size of a "CLEVELAND."

We make parts from bars weighing from 1 ounce to 1000 lbs.

Cleveland Automatic Machine Co., Cleveland, Ohio, U. S. A.

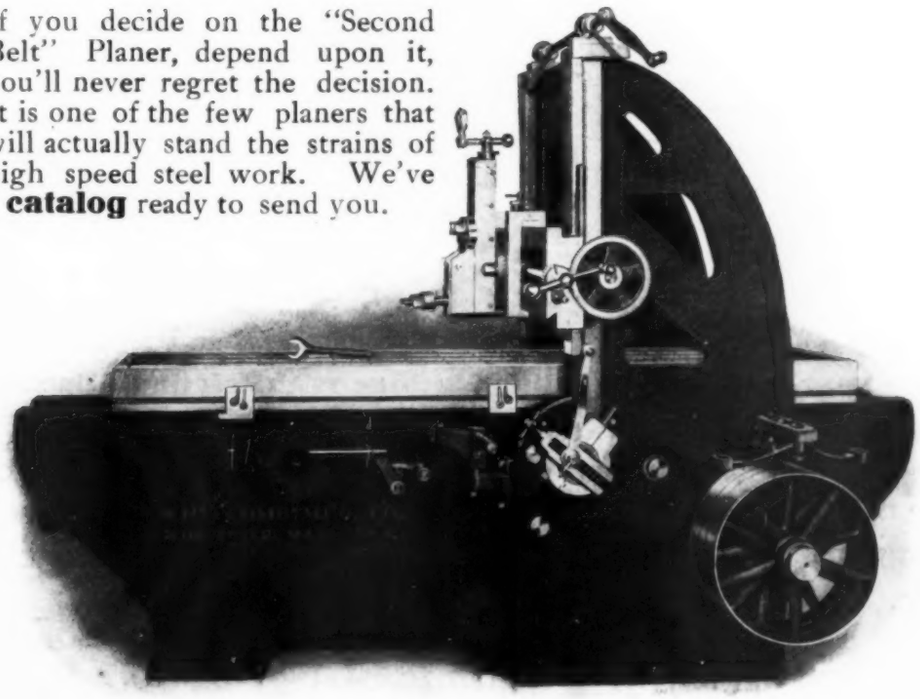
EASTERN REPRESENTATIVE—J. B. Anderson, 2430 North 30th St., Philadelphia, Pa.
WESTERN REPRESENTATIVE—H. E. Nunn, 199 Lake St., Chicago, Ill.
CANADIAN REPRESENTATIVE—G. H. Howard, Dundas, Ontario.
FOREIGN REPRESENTATIVES—Chas. Churchill & Co., London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow. Messrs. Schuchardt & Schutte, Berlin, St. Petersburg and Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano and Bilbao.



The Lathe For NOW

While the cone-driven lathe has its good points, our **New Engine** Lathe contains all of them, besides many **new features** all its own. Increased facility of operation, rigid design and great power. Look it up for **your** shop.

If you decide on the "Second Belt" Planer, depend upon it, you'll never regret the decision. It is one of the few planers that will actually stand the strains of high speed steel work. We've a **catalog** ready to send you.



WHITCOMB-BLAISDELL MACHINE TOOL CO.,

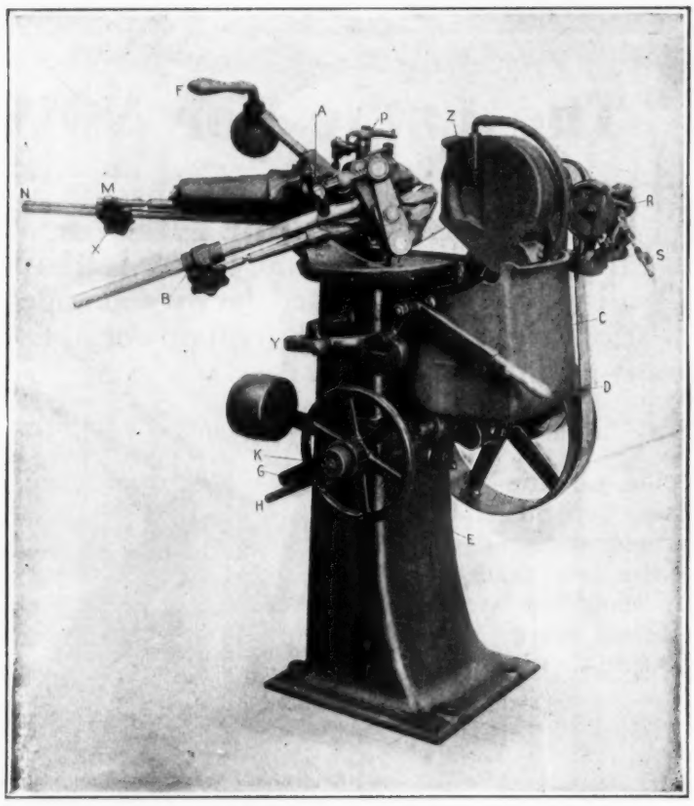
INCORPORATED 1905

134 Gold Street, WORCESTER, MASSACHUSETTS, U. S. A.

William Sellers & Co., Incorp.

PHILADELPHIA, PA.

Labor Saving Machine Tools



Patent Improved Drill Grinding Machine with Pointing Attachment.

For flat and twist drills up to 3 in. diameter inclusive.

Grinds the proper amount of clearance to every part of the cutting edge of the lips.

Adjustable to any angle of drill point from 90 to 130 degrees included angle.

Grinds with flat stone flooded with water without splash, avoiding risk of drawing temper of drill.

Wear of parts, which are made interchangeable, does not cause lost motion.

Does not require a mechanic to grind a perfect drill.

EFFICIENT EXPEDITIOUS ECONOMICAL

CRANES TURNTABLES INJECTORS SHAFTING ETC.

We call them Carborundum grinding wheels—

But they're not.

Carborundum doesn't grind—it cuts. It cuts clean and fast—and without heating or drawing the temper from the finest steel.

Carborundum is hard, sharp and brittle—as hard as the diamond itself.

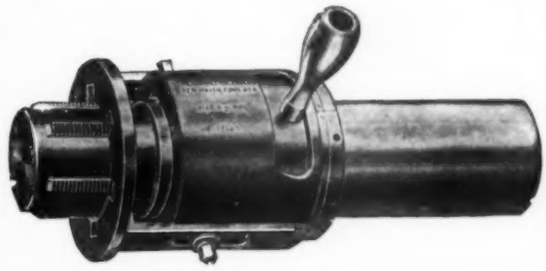
When made into grinding wheels, or sharpening stones the fine crystaline points of which it is composed, break off in use, just enough to keep the cutting surface always sharp and free from gum.

Carborundum wheels never fill up or become gummy.

They require much less dressing than any other abrasive wheel—and this, together with the fact that they cut so much faster and last so much longer than other abrasives, places them away in the lead in point of Economy.

Carborundum ought to be in every shop or factory where there is grinding or sharpening to be done.

The Carborundum Company
Niagara Falls, N. Y.



WHY Our Adjustable Collapsing Tap Is Superior To The Solid Tap

Owing to the graduated index in our Adjustable Collapsing Tap, holes a trifle larger or smaller than the exact size for which the tap is made, may be tapped with accuracy.

It is constructed in such a way that when a hole is tapped to the wanted depth, chasers recede automatically and the tap can be withdrawn at once. No change or injury to thread or tap—no time wasted "backing out."

These are features which mean money "in the till." Try it out in your Tool Department, then you'll *know*. At least, let us quote on *your* requirements.

The Geometric Tool Company

Westville Station

New Haven, Conn., U. S. A.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow and Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. Schuchardt & Schutte Vienna, St. Petersburg, Stockholm and Berlin.

HIGH-SPEED MILLING

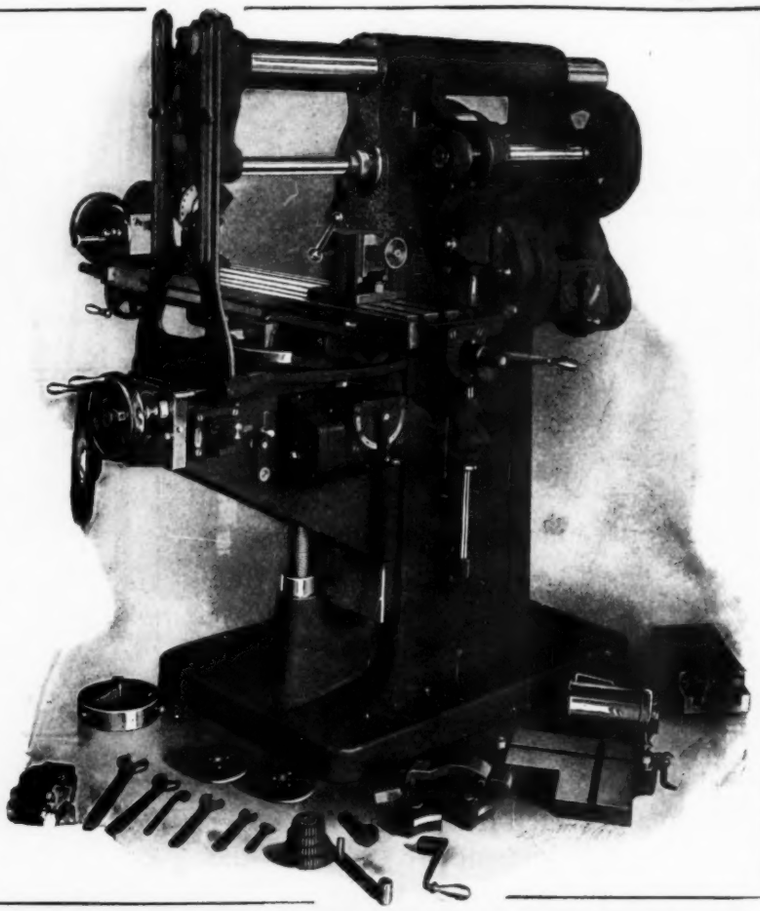
has been reduced to a science on the new No. 2-A Universal "Owen" Miller.
All arbors and spindles of forged crucible steel.
Absolutely no vibration.
Has 32 feeds, obtainable while machine is running without shifting belt or gear.

Special Circular?

The Owen Machine Tool Co.

SPRINGFIELD, OHIO.

ALFRED HERBERT, LTD., COVENTRY, Agents for England.
DE FRIES & CO., AKT. GES., DÜSSELDORF, Agents for Germany.



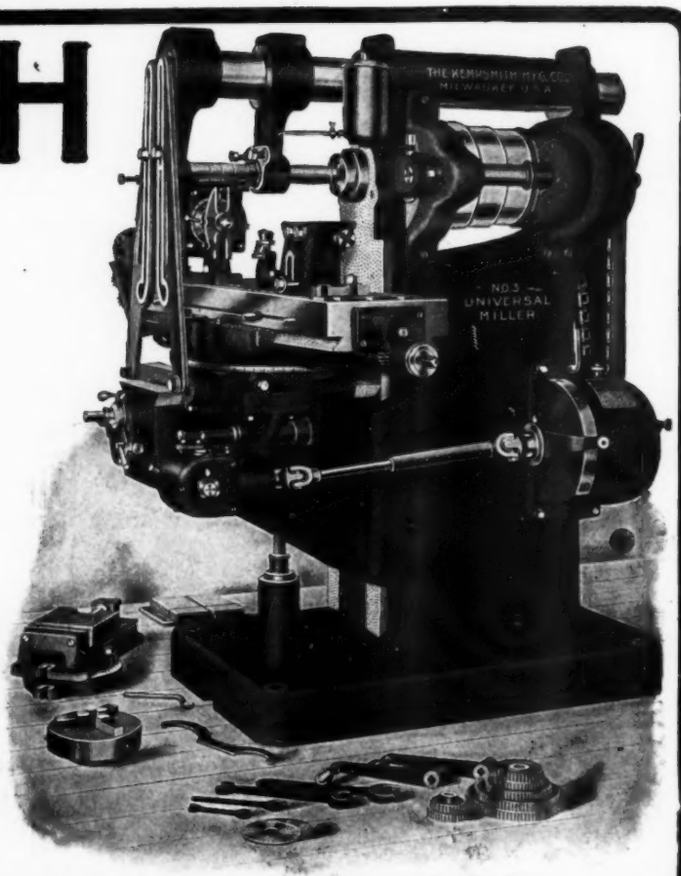
KEMPSMITH

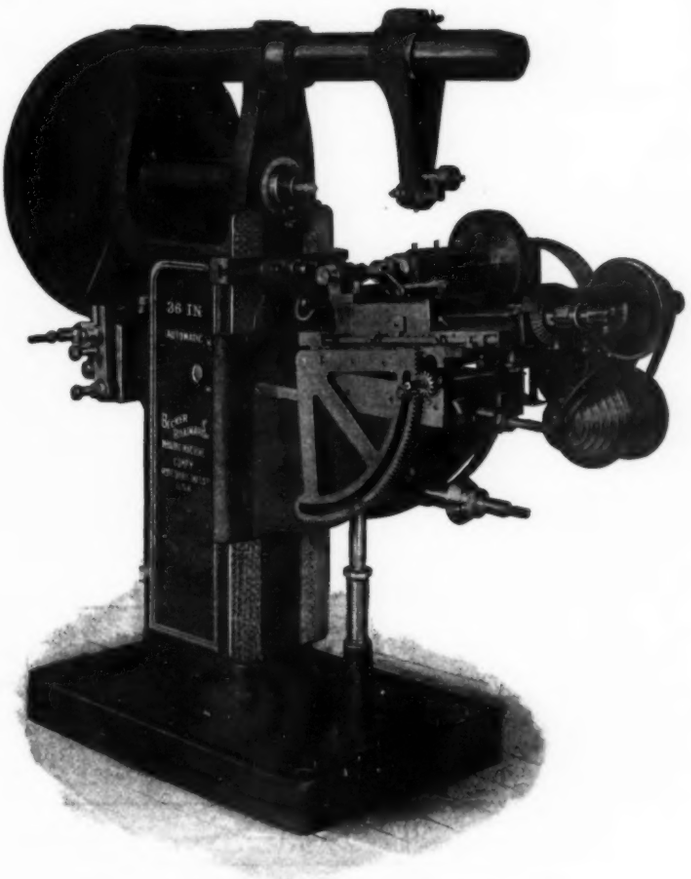
Wouldn't it seem that the powerful construction of this miller, its exceptional range of feeds, and its easy, simple methods of handling, all combined, are bound to result in turning out high grade work about as rapidly as the most advanced practice could expect? It is not a question of machine, but of operator. It is simply up to the operator to get out of the machine the productive capacity that there is in it.

The Kempsmith Mfg. Co.,

Milwaukee, Wis.

European Agents: Selig, Sonnenthal & Co., London, E. C. Agents for Holland and Belgium: R. S. Stokvis & Zonen, Rotterdam. Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.





36 in. Automatic Gear Cutting Machine.

Cuts Gears up to 36 in. Diameter 8 in. Face and 4 Diametrical Pitch.

Every movement is automatic, adjustments can be made quickly, duplicate gears can be produced with the maximum degree of rapidity.

Made to cut spur gears only or spur and bevel gears.

You set the work and the machine finishes the gear without further attention.

We make these machines in 18 and 24 inch sizes also.

If interested write the word "Afstel" on a postal with your address and mail to us.

Becker - Brainard Milling Machine Company,

Hyde Park, Mass., U. S. A.

Branch Offices: The Bourse, Philadelphia, Pa.; Williamson Bldg., Cleveland, O.

AGENTS—McDowell, Stocker & Co., Chicago, Ill. Chas. G. Smith Co., Pittsburg, Pa. J. L. Osgood, Buffalo, N. Y. A. B. Bowman, St. Louis, Mo. A. R. Williams Machinery Co., Toronto and Montreal, Can. Ludw. Loewe & Co., Berlin, Germany. Ing. Vaghi Accornero & Co., Milan. Bevan & Edwards Propty., Ltd., Melbourne, Australia.

ALUNDUM

A THREE CORNERED ARGUMENT FOR

NORTON GRINDING WHEELS

ADAPTED FOR ALL GRINDING PURPOSES

THE purity and uniformity of ALUNDUM are under absolute control. Norton Grinding Wheels are made of this material and must naturally be more uniform and even throughout than those made of natural or artificial abrasives which vary in purity and uniformity. You can do more and better grinding with ALUNDUM wheels than any others. Do you doubt? We are ready to prove it with samples for test.

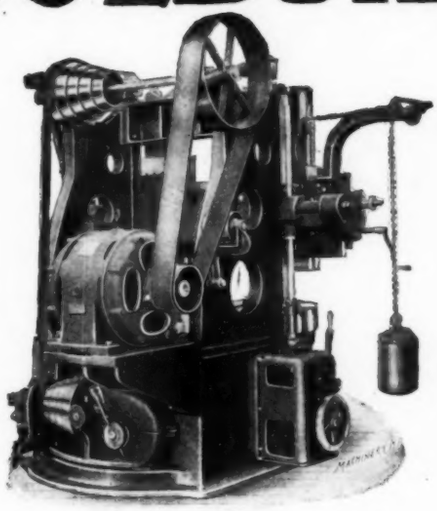
NORTON COMPANY
WORCESTER, MASSACHUSETTS
CHICAGO NEW YORK NIAGARA FALLS
18

Are The Best Tools Too Good For You?

Certainly not! You want the very best, the greatest value for your money, don't you, and that's just exactly what you get when you buy United States Tools. Take for instance this Threading Tool: The shanks are made from a special grade of steel, case hardened, nicely finished. Cutters from solid steel, milled to size and accurately ground to gauge and the only grinding to do is across the top. A sufficient rake is given cutter for clearance, and the serrations in blade and shank allow cutters to be removed and reset at exactly the same cutting point. So you see it has many features not found in other cutters.
Just get the catalog and know all about this and our other tools.

THE FAIRBANKS CO., Springfield, Ohio, U. S. A.

COLBURN BORING MILLS



CONSTANT SPEED MOTOR DRIVE.

Colburn Mills are well adapted for motor drive. They appeal to many buyers because of their compactness and simplicity. The motor is mounted on a heavy bracket and in such a manner as to prevent vibration, and leaves a clear space all around the mill. May be arranged for any style, size or make of motor.

We are boring mill specialists, therefore can serve you especially well on boring mill matters. Afford us an opportunity by writing for our Catalog, and telling us what size you are interested in.

See next week's issue for another type of Motor Drive.

COLBURN MACHINE TOOL COMPANY,
FRANKLIN, PA.

FOREIGN AGENTS: Ludw. Loewe & Co., Berlin and London.

Made in America

PEERLESS

On American Looms

Send for a Sample of PEERLESS TRACING CLOTH

That is the best way to know that it is just as good as the best of imported cloths. That it is perfectly transparent, stands erasures easily and is free from pin holes. Above all, that it is *guaranteed* to be equal in every respect, to the best of imported makes.

Today's mail ought to bring *your* inquiry. Advise us if your dealer does not carry it.

All the larger Stationers, Architects and Engineering Supply Houses sell it.

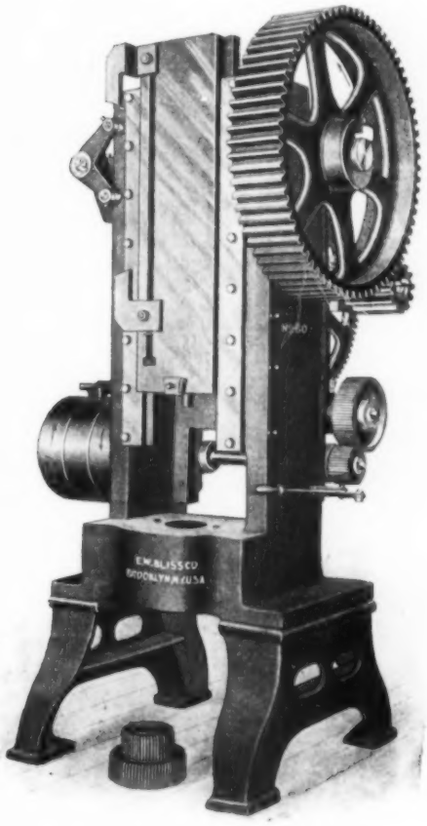
American Tracing Cloth Co.,

Factory: Paterson, N. J N. Y. Office: 11 Broadway

"BLISS"

This Bliss Reducing Press, No. 60

with Rack and Pinion movement, is designed for drawing shells and tubes up to 18 inches in length. As it is heavier and more powerful than other presses of its class, it works more quickly and steadily.



"Bliss" Reducing Presses are particularly desirable for use in the manufacture of cartridges, ferrules, pencil tubes, pencil cases, pen holders, thimbles and many other articles in the brass and silverware lines. For forming, bending and finishing operations on deep work, too.

Why not become better aquainted with these and other types of "Bliss" Presses. Our Catalog will show you how well we can suppy your needs.

E. W. BLISS CO.

ADAMS STREET, BROOKLYN, N. Y.

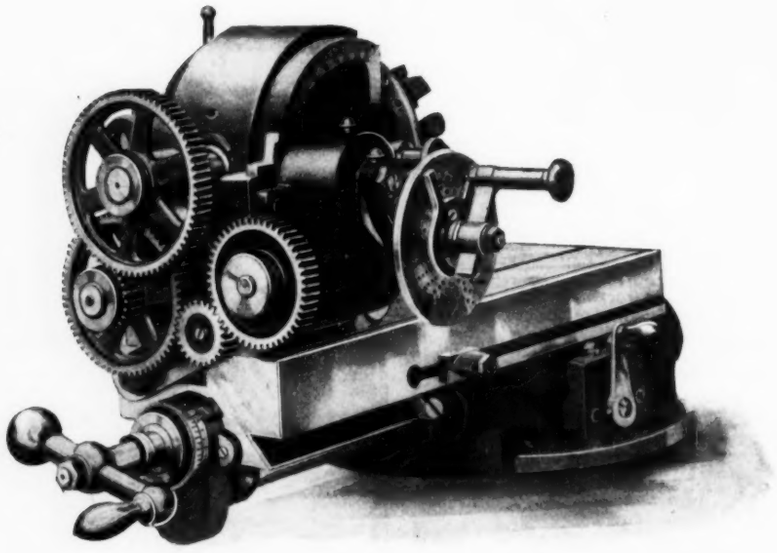
Agents for Chicago and vicinity, Stiles-Morse Co., 138 Jackson. Blvd., Chicago, Ill. EUROPEAN OFFICE—Clichy Pres Paris, France

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

Differential Indexing

A Quick and Accurate Method of Indexing Prime and Large Numbers.



Indexes all divisions to 382

No Extra Plates Required

The three plates that are regularly furnished are the only ones needed.

The Index Plate is geared to the Spiral Head, giving a differential motion that allows the indexing to be done the same as plain indexing.

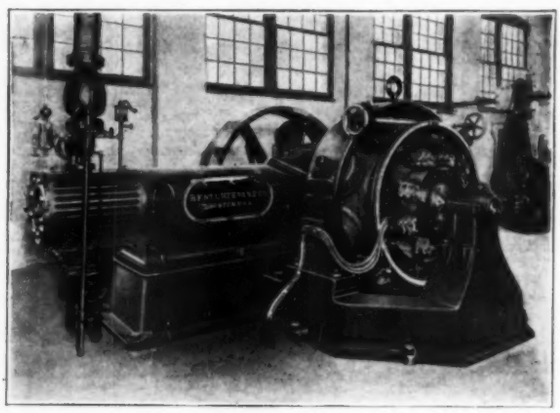
Regularly furnished with B. & S. Universal Milling Machines.

Booklet, explaining fully the Differential Indexing Method, sent free to any address.

See second page opposite Index.

FOR ALL NIGHT LIGHTING

UNDER THE ATTENTION OF THE WATCHMAN



A STURTEVANT GENERATOR SET

proves that it will run if it's only let alone. The engine doesn't need oiling because the pump keeps a pressure of 15 lbs. on all bearings. It doesn't need cleaning because it's entirely enclosed. The generator is likewise built to run without attention.

Send for Bullentin No. 63.

B. F. STURTEVANT CO., Boston, Mass.

General Office and Works, Hyde Park, Mass.

New York Philadelphia Chicago London

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fans, Blowers and Exhausters; Steam Engines, Electric Motors and Generating Sets; Fuel Economizers, Forges, Exhaust Heads, Steam Traps, Etc. 503

We Weld by Electricity

The illustrations herewith shown have been successfully

WELDED BY ELECTRICITY

and should command your attention.

These are simple welds compared with the many difficult ones we turn out every day.

The best method of uniting metals of unequal sizes and shapes.

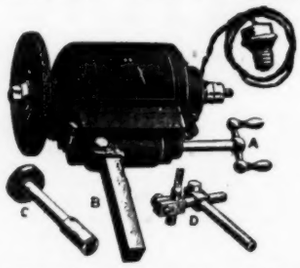
Complete information furnished upon request.

The Standard Welding Co.,

CLEVELAND

SHOP COSTS REDUCED

BY USING THE "HISEY-WOLF" ELECTRICAL TOOL-POST GRINDER



For Grinding Centers, Cutters, Reamers, Dies, Rolls, etc. Also Internal and Surface Grinding jobs of all kinds. 3 sizes: ¼, ½, 1 H. P. Weights 16, 35, 68 lbs. respectively. Used in Lathe, Planer, Shaper or Milling Machine.

Also Electrical Hand Drills up to ¾" capacity.

SENT ON TRIAL.

Power from any lamp socket, direct or alternating current.

THE HISEY-WOLF MACHINE CO.
CINCINNATI, OHIO.
New York Office, 150 Nassau Street.

"READY!"

If you use the Clark Telephones you'll find they're always "ready." See our ad. in this paper in the 1st and 3rd issues of each month. Send for "Catalog M".

The Clark Automatic Telephone Switchboard Co.
Providence, R. I.

This "W-S" Jack

Should Be In Your Shop.

It is especially convenient where heavy machinery is building, because it weighs only 46 pounds, lifts seven tons and is only 13 inches high. It operates in horizontals as well as vertical position. Can be carried in tool box.

Besides this handy tool we make Jacks of all sizes and varieties for every conceivable purpose.

Don't you want the "Jack Book"?

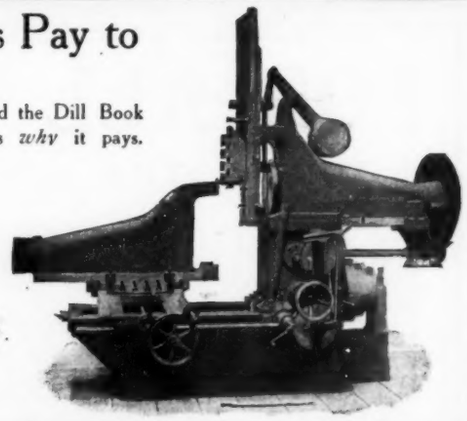
Watson-Stillman Co.
25 Dey St., New York City

Chicago Office: 453 Rookery.
Selig, Sonnenthal & Co., London.

It Certainly Does Pay to

"Do It On the Dill"

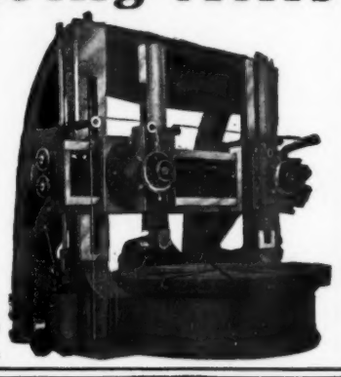
And the Dill Book tells *why* it pays.



The Dill Slotter People,
Philadelphia, Pa.

6-7-8-10 ft. Boring Mills

The Poole Vertical Boring and Turning Mills are of an entirely new design—designed in the age of new requirements—designed for good work, incorporating about every good modern mill feature known. Let us send bulletin.



***The* J Morton Poole Co.,**
Wilmington, Del., U. S. A.

Machine Molding

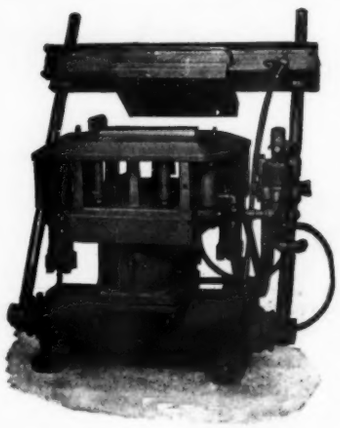
Are you up in the art?

Did you know that you can put

1—a lot of deep work on a spot in your floor called a JOLT-RAMMING MACHINE, and ram it?

2—a deep pattern on any one of a number of Stripping Plate Machines and all on a JOLT-RAMMING MACHINE and mold it?

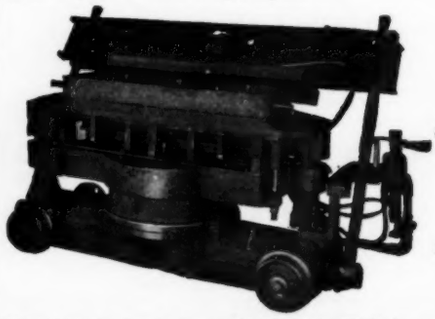
3—a deep Drag, like a Grate Bar, on a COMBINED JOLT AND SQUEEZE RAMMING MACHINE. Jolt-ram the Drag and then squeeze the Cope upon it?



14" x 16" Split Pattern Vibrator Machine.

We can tell you how.

RATHBONE MULTIPLE MOLDING—the fastest molding ever known.

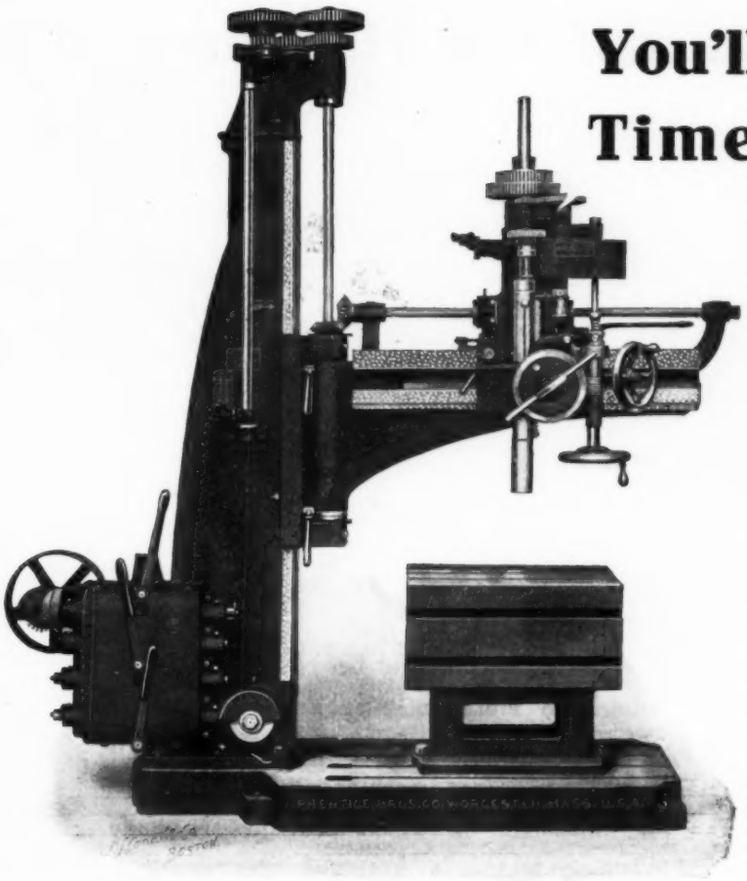


10½" x 40" Bottom Reaming Machine for Radiators.

The E. H. Mumford Company,

17th and Callowhill Sts. Philadelphia, Pa.

J. W. Jackman & Co., 39 Victoria Street, London, S. W. W. R. Colcord Machinery Co., St. Louis Mo.



You'll Save More Time and Labor with a Prentice Brothers Radial Drill than with any other make.

We know this to be true because of its superior construction which embodies special features for the reduction of production expenses. We have had many years of experience in this line and know its needs perfectly—in this Radial we have perfectly met those needs.

You can see by the cut that the Base and Column give greater stiffness than any other form of the same weight. The Arm Swings on ball bearings and locks in any position. It can be *safely* lowered twice as fast as it is raised. The spindle is made from crucible steel forgings; has 16 changes of speed; 8 changes of feed; has quick return and automatic stop motion.

The Gear Speed Changing Device is very simple, of but few gears, so arranged that it is *impossible* to engage conflicting ratios and so injure the machine.

All speeds and feeds can be changed instantly without stopping the machine—from the operator's usual position.

Back Gears prevent strain on driving shaft, and they can be engaged or disengaged without shock. Our Tapping Attachment is of A-1 design and can be backed out at 5 times the in-going speed.

You can feed the drill point faster than the power feed at the start, and so save from 20 to 30 seconds on each hole drilled.

You will have no friction-clutch troubles with this Radial, as our special clutch operates only when engaged and *cannot* slip.

We repeat that this is the best obtainable Radial Drill for time and labor saving, and consequently for increasing profits.

Start in the right direction by sending for our Circular.

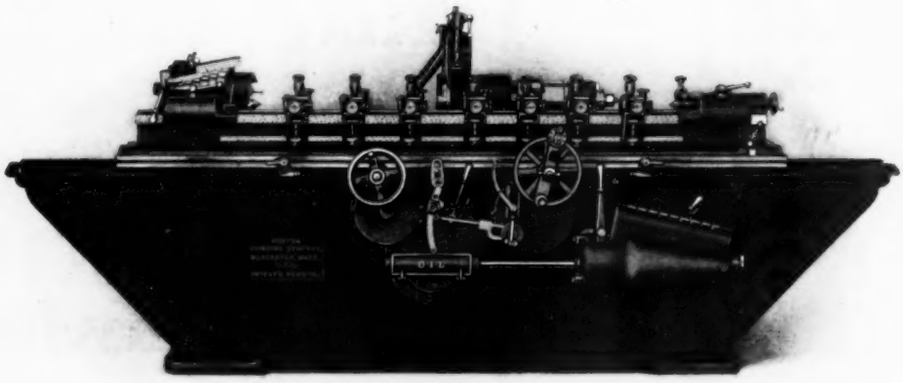
PRENTICE BROS. COMPANY,

"Builders of Radial and Upright Drilling Machines, Engines and Turret Lathes."

Worcester, Mass., U. S. A.

AGENTS—The Fairbanks Company, New York, Albany, Boston, Philadelphia, Syracuse, Hartford, New Orleans and Buffalo. The Strong, Carlyle & Hammond Co., Cleveland and Detroit. The Baird Machinery Company, Pittsburg. The O. L. Packard Machinery Company, Chicago and Milwaukee. The Marshall & Huschart Machinery Co., St. Louis. The Thornton Machinery Company, Providence. Alfred H. Schutte, Cologne, Paris, Bilbao, Milan, Brussels and Liege. Schuchardt & Schutte, London, Berlin, Stockholm, St. Petersburg and Vienna.

? About To Install New Machinery ?



IF A GRINDER is on your list, there are many reasons why you should know the Norton Grinder.

Having a wide range of speeds, which can be changed without stopping either the work or wheel, no vibration, ample provision for a large water supply, no pipes or channels to become clogged, you'll quite agree with us that they are the proper machines for your plant. We show here our 10" x 72" machine, on which provision is made for grinding tapers up to 1½" per foot. It has a center grinding attachment arranged to grind the center points perfectly round, true and 60° angle, has an improved overhead works, shafts are of best material, ground on centers, bearings are self-oiling.

Now we'd like to tell you all about it, or, if this isn't the one you want, we'll gladly send our catalog.

NORTON GRINDING COMPANY

WORCESTER, MASS., U. S. A.

Ludw. Loewe & Co., Ltd., London, Berlin, European Agents.

HIGH SPEED DRILLS IN STOCK

FULLY GUARANTEED

Capital Drills made from special drill quality are hard and tough.

They will run at the highest obtainable speed.

Capital Drills Will Do Many Times the Work of Ordinary Drills

BUY THE TOUGH ONES.

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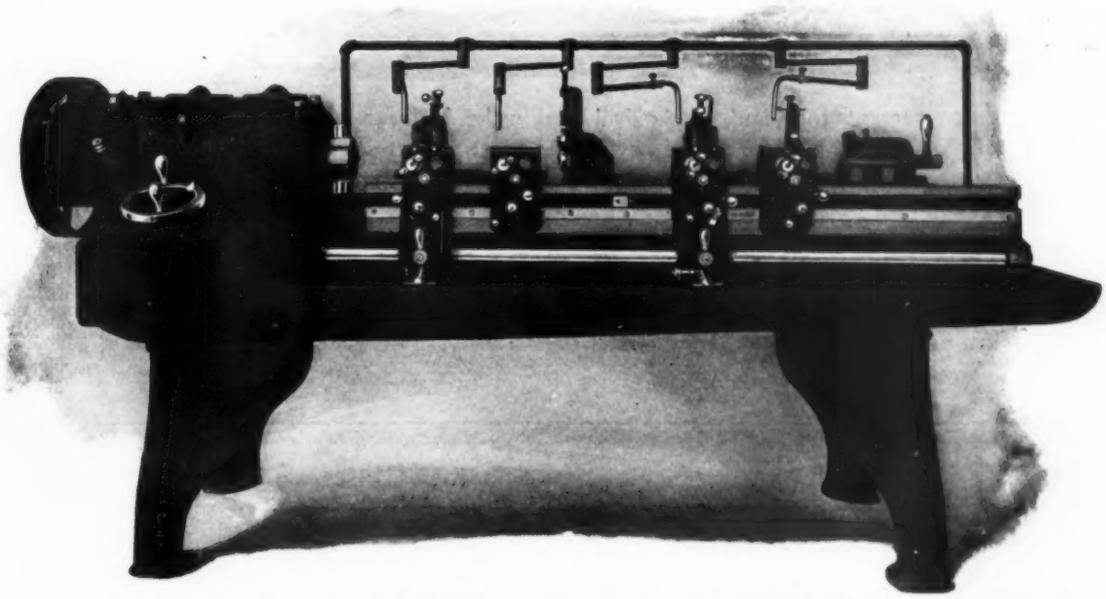

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HALF as many Belts on the line shaft.
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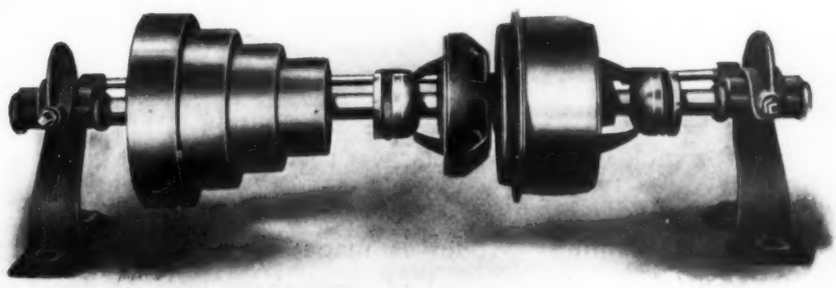
Extra power required to keep *extra* Pulleys and Belts in motion **SAVED.**



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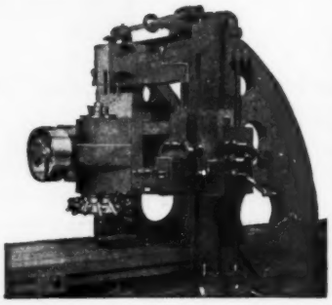

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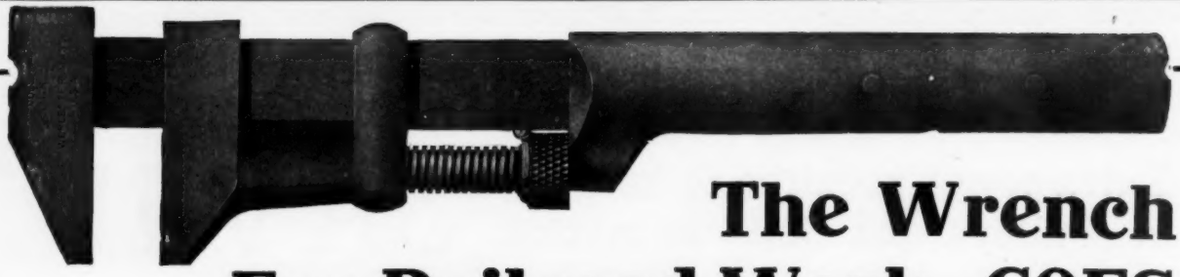

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It's conclusive evidence that this "Steel Handle" Wrench is **the** wrench for such work, or the largest roads would not adopt it as they have.

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All rivet holes are reamed to size after work is assembled.

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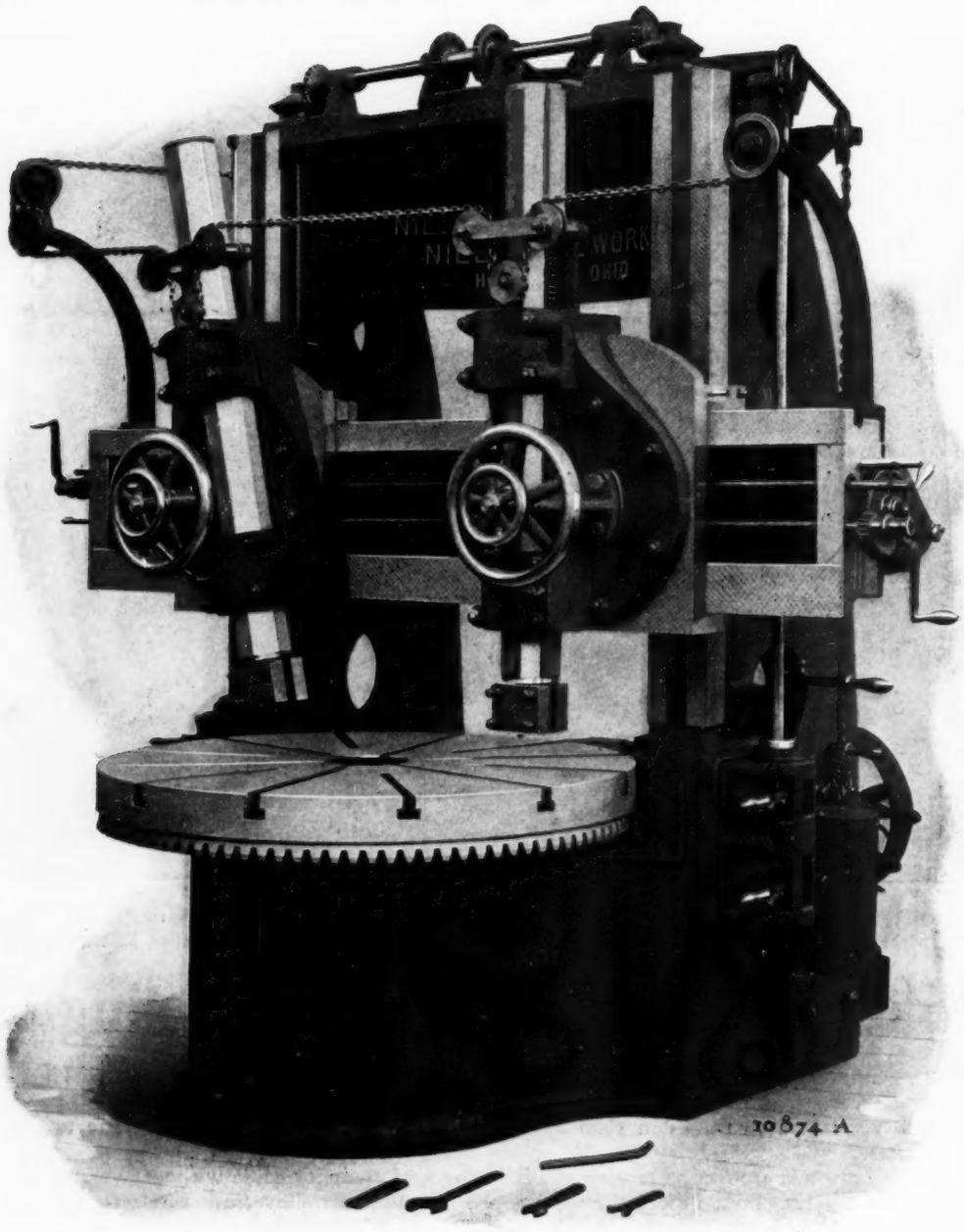

Niles 51-inch Boring and Turning Mill, Single Pulley Drive.

Single Pulley Drive makes full power of machine available at all speeds. Motor Drive—Direct connected through speed box. 16 changes of speed. *No Belts.*

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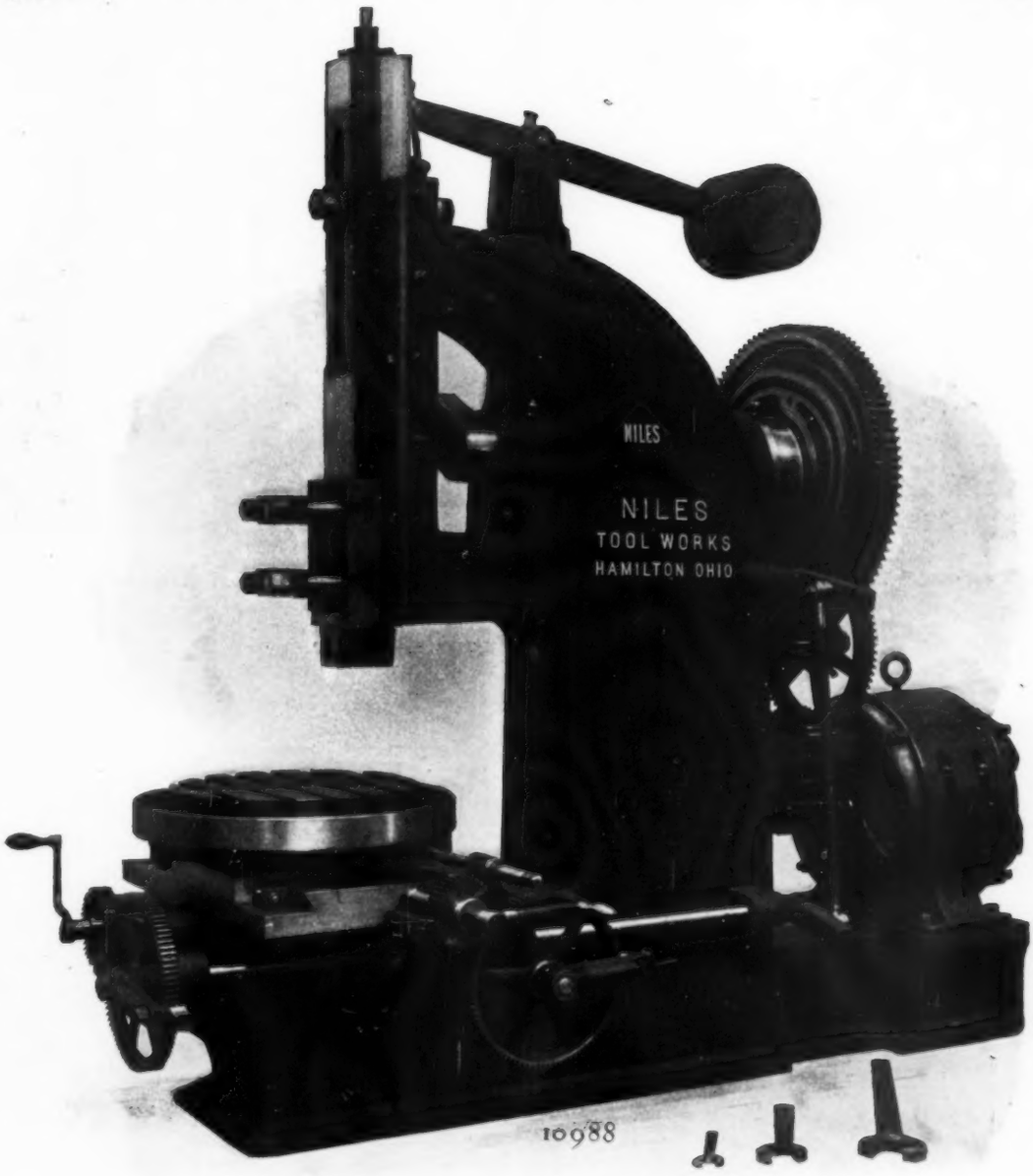

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An especially heavy machine driven by 7½ h. p. motor having speed variation of 3 to 1. With a motor having this speed variation, no changes of speed by gearing are required, as any speed of the cutter bar may be had by moving the controller handle. Table is 26 inches diameter, has 18-inch longitudinal traverse and 18-inch cross traverse. Will take work 48 inches in diameter.

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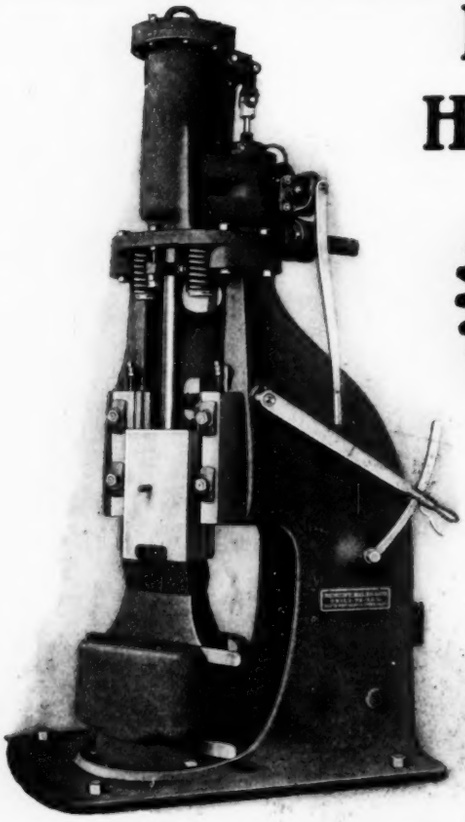

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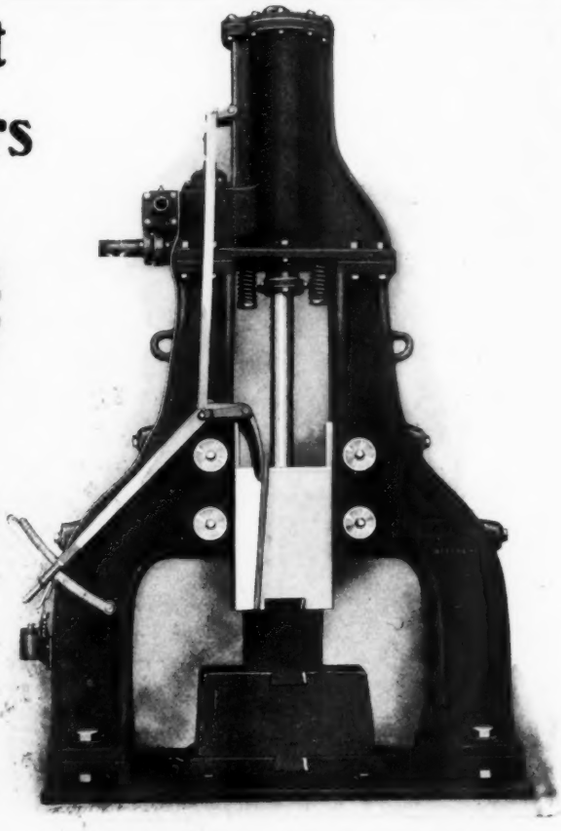

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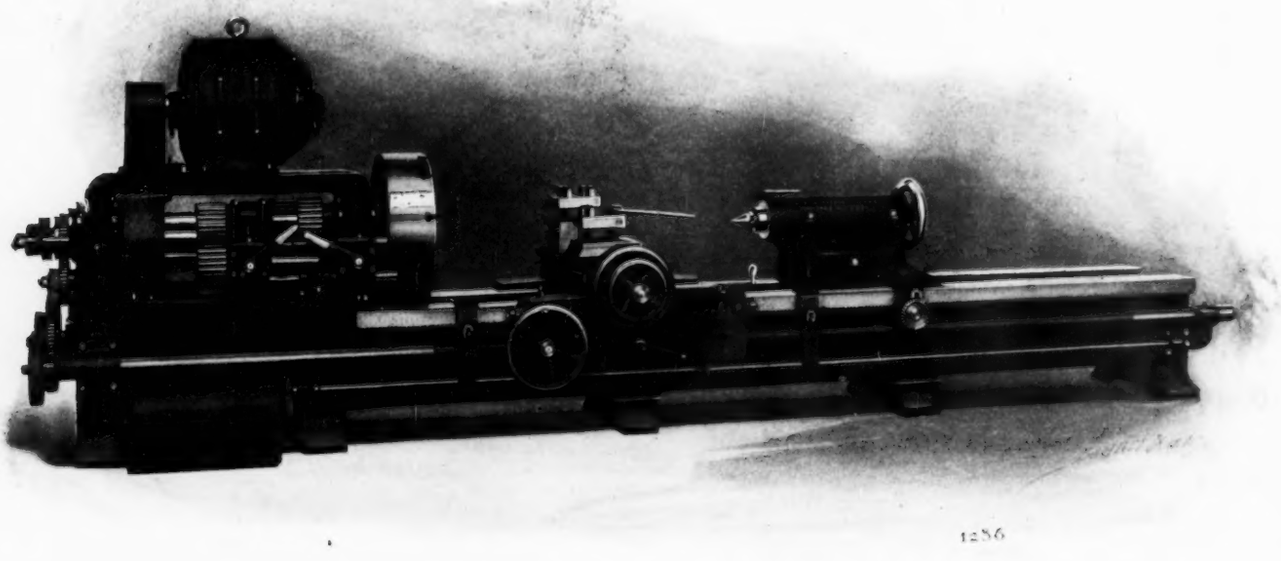

30-Inch Rapid Reduction Lathe for use with High Power Tool Steels.

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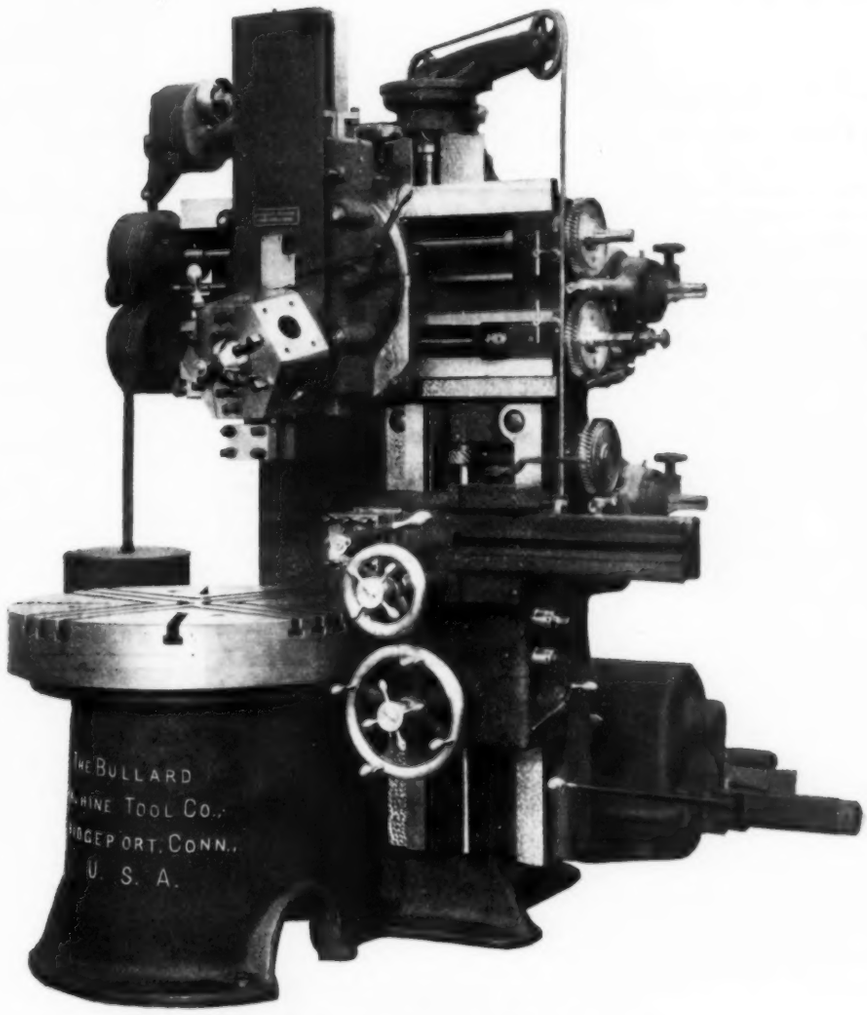

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VERTICAL TURRET LATHE

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Why not investigate what this Lathe could do on your work? Begin by writing for our catalog No. 30.

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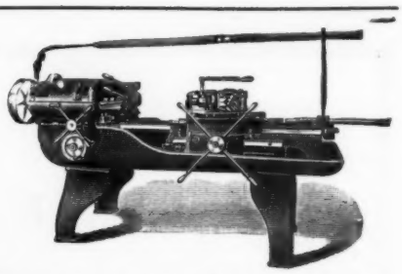

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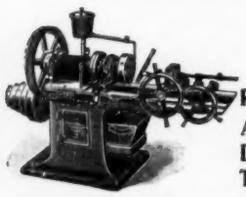

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Acme Single, Double and Triple.

Automatic Bolt Cutters. Cutting from 1-8 in. to 6 in. in diameter.

Also Separate Heads and Dies.

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We HAVE MANY Visitors

who are not particularly interested in Planers, but who want to go through the shop because they say our planers have an international reputation, and realizing there must be a reason for the reputation they desire to investigate our methods of doing work.

As seeing is their only possible object, their presence confirms the sincerity of the compliment.

THE G. A. GRAY COMPANY

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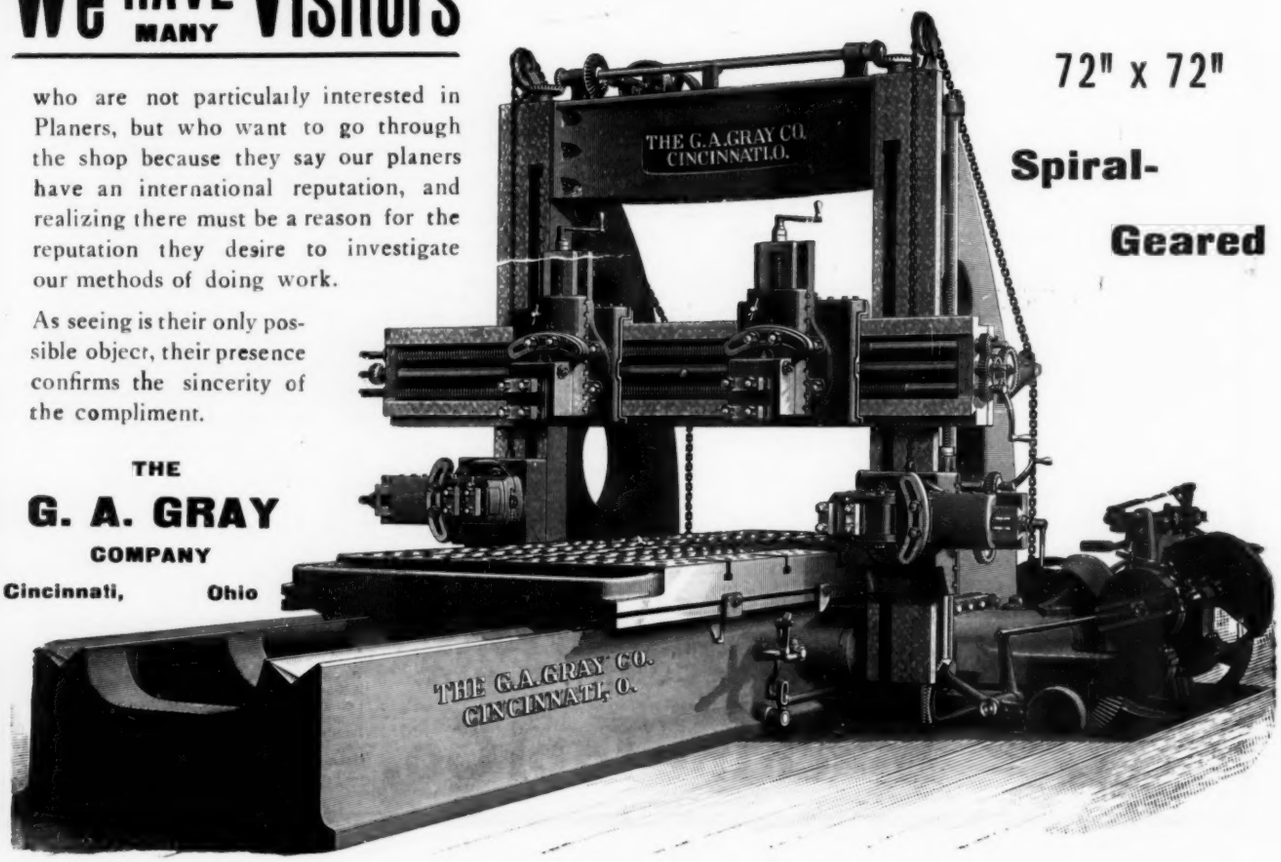


THE MANUFACTURE OF A DETACHABLE SPROCKET CHAIN

A Machine for Forming and Assembling Links, Using an Ingenious Set of Dies—How a Self-Controlling Reel Takes Care of the Chain as It Leaves the Press—A Continuous Hardening Performance in an Oil Furnace—Tempering Chains and Inspecting and Testing Them

The engravings illustrate some of the machines and methods employed by the Locke Steel Belt Company, of Bridgeport, Conn., in the manufacture of its detachable sprocket chain.

THE CHAIN AND ITS USES

This steel chain is made from flat stock of low carbon, is hardened and tempered, and is light and strong. It is adapted for use in agricultural machinery, in conveying and elevating apparatus for certain classes of material, and in other machinery utilizing chain transmission. As regularly manufactured it ranges from ½- to 3-inch pitch, and the stock from which the links are formed is 0.045 to 0.300 inch thick.

CHAIN MADE COMPLETE IN ONE MACHINE

A short section of chain will be seen in Fig. 1, which shows three links finished and assembled, while the portion to the right represents the preliminary stages in the production of the chain. The operations of blanking, cutting off, forming and assembling the links are carried on in the same press, and at each stroke a new link is added to the chain.

FIG. 1. SHOWING THE EVOLUTION OF THE CHAIN

THE FORMING AND ASSEMBLING PRESS

Fig. 2 gives a good idea of the chain machine, this particular press being one of several designed by the superintendent of the plant, S. D. Locke, and built by Vieillard & Oswald, Brooklyn, N. Y. As shown

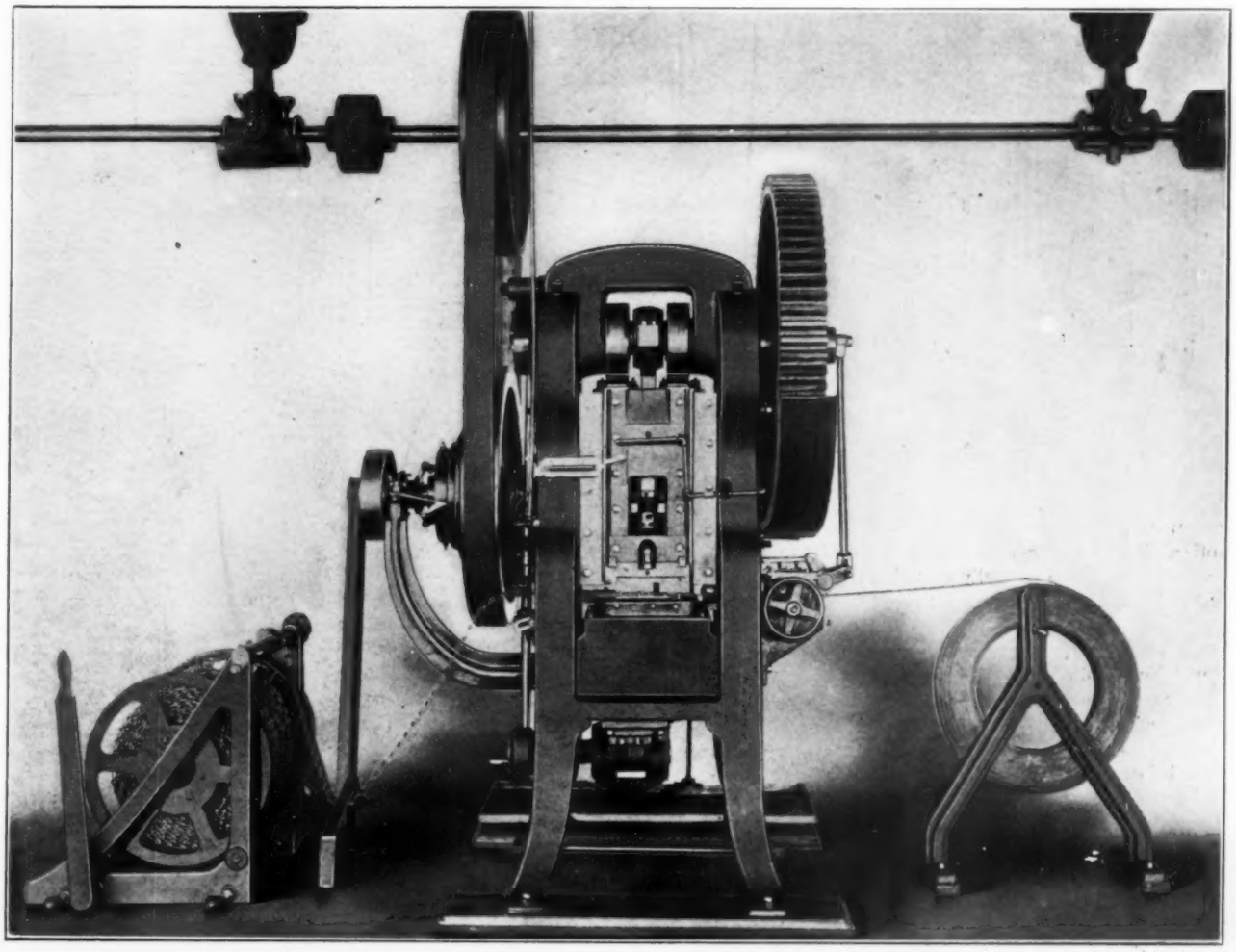


FIG. 2. THE CHAIN PRESS

in this view, the stock passes into the press from the coil at the right, and the finished chain is wound up on the reel to the left. The material as obtained from the mills is of the right width for the links, and no stock is wasted in trimming edges. In fact no material is wasted at any point in this chain-making process, for the stock forced out of the center of the link is curled up, as represented in Fig. 1, to form the ends and the connection with the preceding link. As a result of this method, one hundred feet of stock for ordinary sizes of links will produce about 95 feet of finished chain.

CONSTRUCTION OF THE PRESS

The press construction will be understood from the half-tone and from the line engravings, Figs. 3 and 4. As will be noticed, it is a double-action machine of a heavy design, and powerfully geared. The slides have long guides, and the double movement is obtained by means of a crank and a pair of cams acting against broad-faced rollers. At the left side of the press is a cam-actuated mechanism operating what amounts to an auxiliary press placed in an inverted position under the main bolster. Its function will be referred to later.

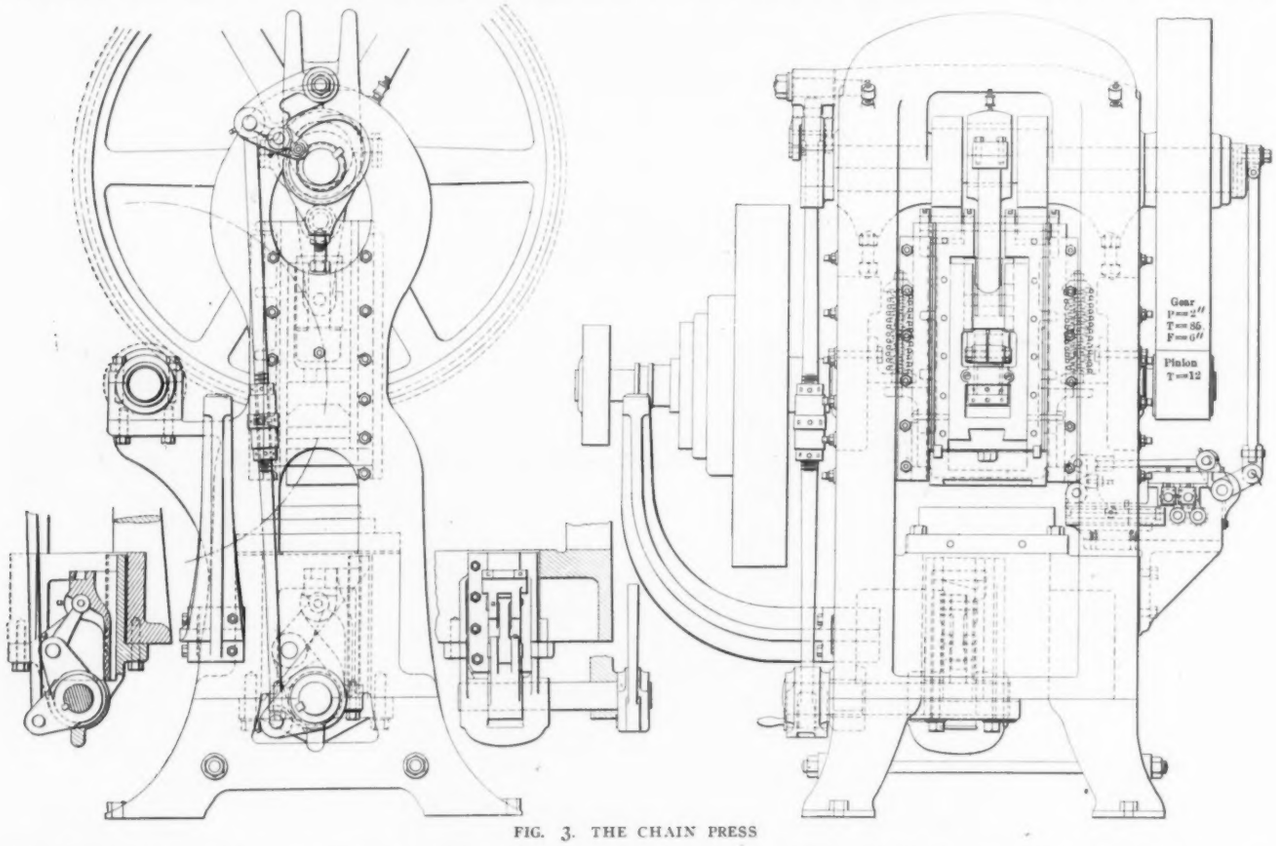


FIG. 3. THE CHAIN PRESS

THE STOCK FEED

The feed motion is derived through a connecting rod actuated by a slotted crank disk at the right of the large driving gear. The feed mechanism gives a positive movement to the stock as it passes between the straightening rolls and into the dies. The construction of this mechanism is quite simple, and will be clear upon inspection of the section presented in Fig. 4, which shows the feed device in its forward position.

OPERATION OF THE FEED

The gripping dog *A*, carried by slide *B*, which is reciprocated by the connecting rods, rocker arms, etc., is so mounted on the slide as to have a slight rocking movement independent of the action of the slide. Now, as connecting rod *C* is drawn back it first rocks *A* backward until its gripping edge at the bottom is clear of the stock; the upper part of *A* then strikes lug *D*, forming part of slide *B*, and the slide must then recede as long as the connecting rod is on its back stroke. Upon the rod starting forward it rocks *A* ahead, forcing its lower edge hard against the stock and then slide, stock, and all, feed forward. The movement and position of the slide and feed dog are, of course, readily adjusted by the means indicated in the drawing.

THE PRESS TOOLS

The press tools for one size of link (1 25/64-inch pitch) are shown in Fig. 5. These tools are built up of machine-steel bodies with tool-steel pieces inserted. The punch holder *A* is fitted to the inner slide or ram of the press; upper die *B*, which acts as a clamp plate, is carried by the outer or cam-operated slide; die *C* fits the bolster. *D* is a bending or folding punch, which in operation passes up through an opening in die *C*, it being operated by the toggle-jointed inverted mechanism placed under the bed of the press, as represented in Fig. 3.

FIRST OPERATION ON THE STOCK

Referring now to Fig. 1 and examining that engraving in conjunction with the drawing of the tools, we may trace the sequence of operations performed by the dies. On the first down stroke after the admission of the stock the work is gripped by *B*, and punch *E* passing down through the corresponding square opening in *B* forces the work down onto projection *a* and two knives *b* carried by the die *C*. Similar knives are fitted to the punch at *c* and a longer knife located crosswise at *d*. The result of this stroke is the nearly semi-circular "hump" seen nearest the right-hand end of the strip in Fig. 1; two deep cuts in each side of the metal which outline the width of the inside of the link that is to be made; and a crosscut made by knife *d* along the top of the hump or bend in the strip.

OUTLINING THE LINK

Upon the up stroke of the press the work feeds ahead until the loop first formed in the material drops over projection *e* in die *C*. On the second down stroke knives *f* in the die and *g* in the punch cut cross grooves joining the rear ends of the cuts already made for the inside of the link blank, and at the third stroke when the first hump or loop formed in the strip has passed over projection *h* of the die, the stock at the center of the link is forced downward and curved in

each direction by punch *F* which passes through the square opening near the center of plate *B*. Another stroke severs the link blank and causes punch *G* to force the tongue of metal well down from the body of the link where the bending tool *D* can operate upon it on its upward stroke.

BENDING AND CONNECTING THE LINKS

The first link now lies in the die recess at *i*, and as the following link after passing through the same operations as its predecessor reaches the position over tool *D*, the strip of metal depending from the inner end of the link is curled upward and

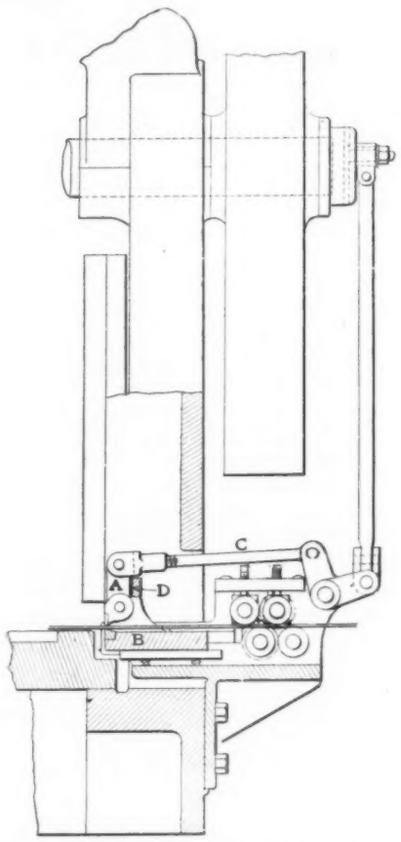


FIG. 4. FEED MECHANISM OF CHAIN PRESS

ahead by portion *j* of the bending tool and wrapped around the rear end of the link preceding; the semi-circular recess *k* in plate *B* bringing the end of this connecting strip nicely to shape. It is obvious, now, that at each stroke of the press, another link is completed and attached to the chain, which, as assembled link by link, is withdrawn from between the dies by a simple form of feeding device and wound up on the reel.

PROVISION FOR DETACHING LINKS AND FOR CLEARANCE

As will be noticed upon inspection of the link at the left-hand end of the portion of chain in Fig. 1, the curled-up connection does not quite complete the circle at the link end. The gap thus left in forming the links permits any member of the chain to be detached by simply turning it on the next link through an angle of about 60 degrees and then sliding it sidewise until free.

The knife cuts made in the stock during the first operations on the links are shown clearly in Fig. 1 and it will be seen that the side cuts are not quite parallel. This provides for an opening in the link which is of the right shape to form working clearance for the next link attached.

SOME ADVANTAGES OF THE BUILT-UP DIE

The arrangement of the dies and the method of holding the work during each operation are such as to insure the accuracy of the pitch being maintained within the necessary limits; and the built-up construction permits the easy grinding and replacing of the knives and such other portions as are naturally inclined to wear quickly.

THE CHAIN REEL

The reel which receives the chain as it

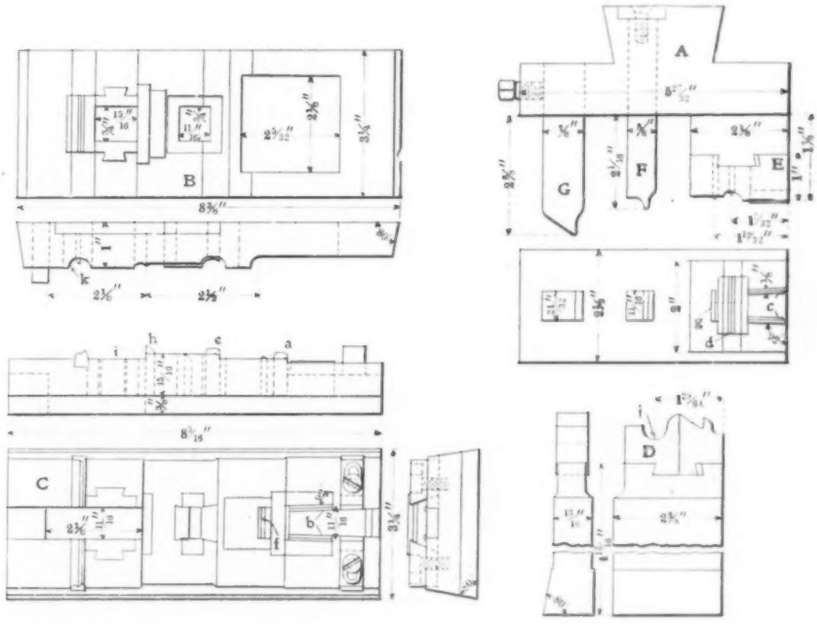


FIG. 5. THE PRESS TOOLS

emerges from the press is quite as ingenious in its way as the rest of the apparatus connected with this manufacturing process. The reel proper is a metal spool with large flanges resting normally on four rollers—two for each flange. When the lever at the side of the metal frame is turned down, the two rear rolls drop sufficiently to allow the full reel to roll out of the frame and a new one to enter in its place. Upon the lever being returned to vertical position the reel is lifted against the rear rolls which act as drivers.

THE REEL DRIVE

The illustration does not bring out the reel mechanism very clearly but a similar device is shown in the hardening-plant view in Fig. 6, and a brief explanation will be sufficient to make the operation clear. The rolls at the rear which serve as frictional drivers against the faces of the reel flanges are driven by bevel gears which are themselves actuated by a friction pulley which, as represented in Fig. 2, is belted from a small pulley on the driving shaft of the press.

CONTROL OF THE DRIVING MECHANISM

In order that the chain shall never be drawn too tight, or on the other hand allowed to slacken so as to drag on the floor, an intermittent motion is imparted to the reel; that is, before the chain becomes taut the reel stops, and automatically starts again before the slack of the chain touches the floor.

This action is controlled by a friction clutch at the back of the driving pulley on the reel, a cam at the opposite side of the pulley, and a long arm which is attached to the cam and extends out and rests over the chain.

STARTING AND STOPPING THE WINDING ACTION

Although the reel is speeded very slowly its tendency is to wind the chain in too fast, and this tendency naturally increases as the reel fills up. But as the chain approaches a taut condition the cam arm resting on it is lifted sufficiently to turn the cam back and release the friction drive. The chain now sags more and more with each stroke of the press until, when well down, the cam arm, still resting on it and following it as it drops, allows the driving friction to again engage the pulley and the reel then starts again and winds in the chain.

GUIDING THE CHAIN

The guide which slowly feeds the chain to and fro across the reel as the winding proceeds is mounted on a screw provided

with simple reversing mechanism and actuated by sprocket wheels and chain as shown more clearly perhaps in Fig. 6, the upper sprocket in the system being carried as there indicated at the end of the traversing screw.

The reel when wound full weighs in the neighborhood of 500 pounds, one-fifth of which is the weight of the appliance itself.

A HARDENING FURNACE

The view in the hardening room, Fig. 6, shows one of a number of oil furnaces in this department designed for handling the chain with despatch. The furnace is built obliquely, and the oil and air connections are so arranged as to provide an even and

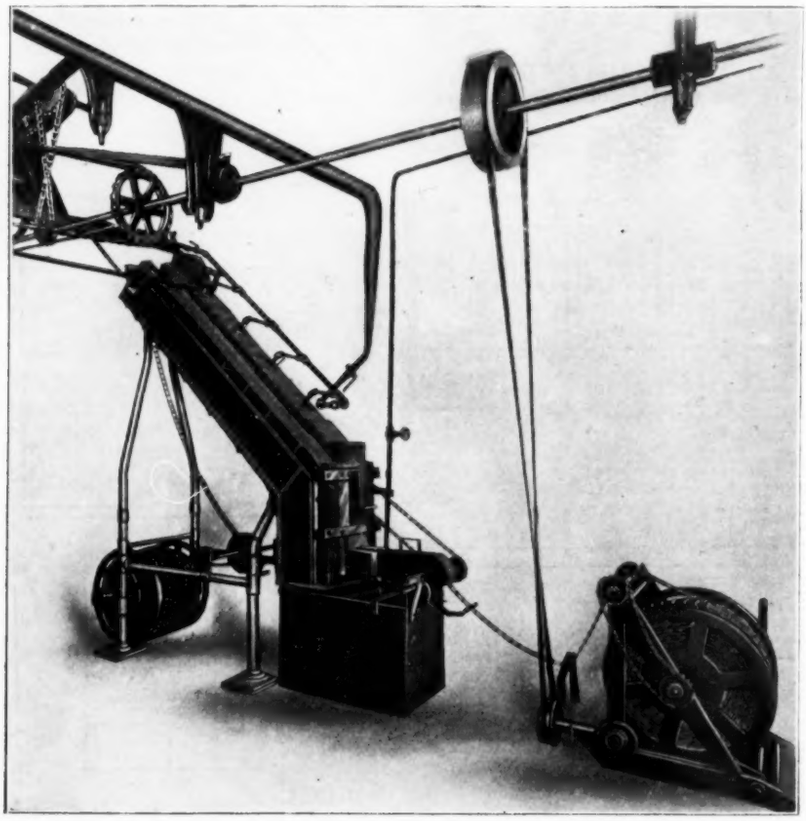


FIG. 6. ONE OF THE HARDENING FURNACES

easily regulated heat throughout the chamber. The lower end rests on a tank through which fresh water is kept in circulation, and feed sprockets are arranged at top and bottom for drawing the work down through the sloping chamber. The speed of the sprockets is regulated to suit the size and type of chain in hand, by means of friction driving cones.

PASSING THE CHAIN THROUGH THE FURNACE

The reel with the unhardened chain is located at the rear of the furnace frame, the chain being led up over the different sprockets and down the inclined passage. It comes out of the furnace at a speed, usually, of about six or seven feet per minute, plunges hissing into the bath of fresh water, passes out of the tank quite cool and is coiled on the reel in front. Upon the latter being filled about flush with the flange peripheries the mass of chain is ready for tempering.

A TEMPERING OPERATION

This operation is accomplished by placing a cast-iron hood over the reel and immersing the whole thing in a tank of oil heated to about 620 degrees Fahrenheit and leaving it there for half or three-quarters of an hour, at the end of which time the work is lifted, cover and all, by the crane and deposited on a circular table heated by oil from underneath. Here it rests for perhaps another half hour and during this time while protected by the hood from the action of the air, the oil is baked evenly and hard on the chain, giving it a smooth, enameled appearance.

INSPECTION AND TESTS

The chain is shipped ordinarily in 10-foot lengths, each of which is previously inspected and compared with a standard 10-foot length of the same pitch. Then one end being secured, the other is attached to a weighted lever, a certain definite load applied and the chain then examined to see if it has stretched beyond the permissible limits, or reveals any other defects. On account of its higher elastic limit steel chain can be tested up to the breaking point of ordinary cast chains. The actual breaking strength of the chain is tested by removing three links from each length and pulling apart in the testing apparatus.

SPECIAL ATTACHMENTS

Only the regular form of sprocket chain as made by this concern has been shown in this article; there are, however, numerous other forms made by them, which are more or less of a special nature. In all cases the method of forming the chain proper is identical with the one described, the special features consisting usually of attachments in the forms of ears, or clips, which are secured to the sides of the links, these extra pieces being used for mounting cleats, buckets, etc., which are held in place by riveting. F. A. S.

Evils and Restrictions of Carelessness *

BY THOS. D. WEST

While this discourse should interest all manufacturers and the general public, especially since our worthy President Roosevelt, in referring to injuries and deaths connected with the mechanical arts in his message to Congress of the 4th inst., states that the law should place the entire "risks of a trade" (having reference to accidents and deaths) upon the employer, it is particularly of value to founders, owing to the fact that the greatest loss incurred to proprietors of these industries is generally due to the want of carefulness. There has been much written on the subject of the need of experience and brains, in making good castings, but little upon carelessness, which is really the factor causing the greatest loss to founders, for it not only includes bad castings, but the destruction of life and property, which in themselves have ruined concerns or crippled them so that they had a great struggle to exist.

In broadly considering the subject of carelessness, and to get at the root of the evil, we are compelled to go outside of the four walls of our foundries.

Of course it is true that all accidents are not due to carelessness, nevertheless it is safe to say that three-quarters of them are caused by the lack of thought and intelligence, or by downright carelessness.

When an accident occurs in a foundry or other industry that maims or kills, the first thought of the public is, as a rule, to hold the employer responsible, and he is often looked upon as one who cares little or nothing for life or limb. The accident that took the life, might be such as to destroy the shop, fixtures and tools, and the costs to repair the damage might financially embarrass a firm so heavily as to eventually cause its failure.

Few outsiders or even the great majority of employees have any conception of how almost all employers dread acci-

*Extracts from an address read before the New England Foundrymen's Association, Boston, Mass., Dec. 12, 1906.

dents and strive to prevent them, often spending thousands of dollars to help guard against their occurrence.

We have come now to the point where we can properly ask, what is the cause of carelessness? The manifestations of carelessness are due to the following causes:

First, to the lack of proper restraint. As a rule, the man that has one or more jobs awaiting his acceptance is not the careful worker as is the one who would not know where to get a job were he out of employment. He is beyond proper control.

Second, to the lack of responsibility. The man with no one to support but himself does not feel it necessary to be as careful as the father of a family.

Third, to a flippant disposition. The one who will not take work seriously.

Can there be any form of education and training that is really more necessary to our existence than learning to be careful? No one can tell the hour when they might be maimed or killed by some other person's carelessness.

We have our fire-drills for the purpose of preparing children to act in moments of peril. It would be no stretching of ingenuity to devise studies, methods and drills to develop and test carefulness. Where is there a school book today that contains a lesson on this life-saving requisite? The adult that graduates from college is no more trained in this important qualification than the child ending its primer.

Some of our foundrymen may think that this address has branched out beyond their interests, but all are reminded that if we casting manufacturers are to have less losses through carelessness in our plants, we must as a body get to the root of the evil, and this lies in assisting to shape the course of our educational systems and home training, as well as in aiding to develop a sentiment of respect and support for carefulness among the masses.

Air-compressor Indicator Cards

BY MAX KURTH

Men who have charge of air compressors are naturally desirous of knowing the condition of their machines and in most cases the indicator is called upon to give a picture of the behavior of the air within the cylinder walls.

In the following, comments are made upon the irregularities which occur in compressor practice. Good air-compressor cards are similar to the one shown in Fig. 1, the intake line dropping very little below the atmospheric line, indicating ample area through the inlet valves which open at the proper moment, when the reëxpansion curve of the air retained in the clearance spaces at the end of the stroke intersects with the atmospheric line. Very little can be said about the compression curve, as in order to get an idea as to the effect of the jacket cooling, the theoretical curves, isothermal and adiabatic, must be plotted. The action of the discharge valves is satisfactory, the valves offering ample area and the resistance to the air passing through them being scarcely noticeable. The clearance spaces are reduced to a minimum, which insures rapid drop of the reëxpansion curve and large volumetric efficiency.

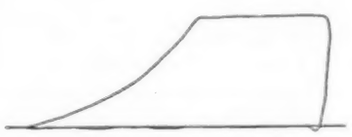


FIG. 1. Practically Perfect

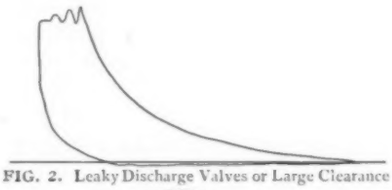


FIG. 2. Leaky Discharge Valves or Large Clearance

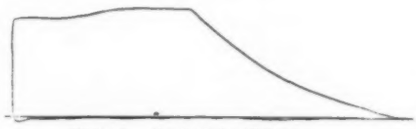


FIG. 3. Leaky Inlet Valves

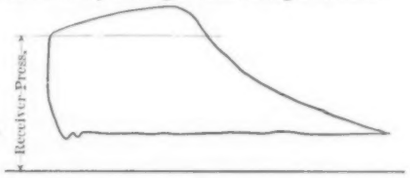


FIG. 4. Restricted Discharge Valve Area

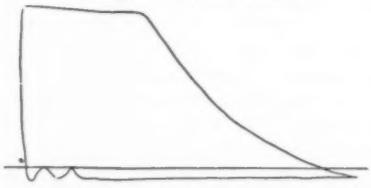


FIG. 5. Restricted Inlet Valve Area

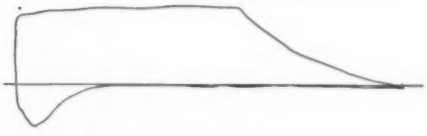


FIG. 6. Inlet Valves Open too Late

AIR-COMPRESSOR INDICATOR DIAGRAMS

The card shown in Fig. 2 was taken from a 10x12 compressor running at 150 revolutions per minute and compressing to 100 pounds gage. The reëxpansion curve drops very slowly and the retarded opening, which according to the clearance spaces (previously figured) should be much less, leads to the conclusion that the discharge valves are leaky, allowing the air in the receiver to flow back into the cylinder. It is understood that before coming to such conclusion the size of the clearance space must be known, as such reëxpansion curves are also experienced when the discharge valves are tight, the clearance spaces, however, being excessive.

Fig. 3 indicates leaky inlet valves which cause the reëxpansion line to drop off suddenly. This, however, should not be confounded with cards from compressors fitted with overflow passages leading the air in the clearance spaces to the other side of the piston.

Fig. 4 indicates restricted discharge-valve area whereby the air is prevented from being rapidly carried through the valves, thereby raising the pressure instantly and even to a danger point.

In stage compression the low-pressure cylinder may produce similar cards even with sufficient discharge-valve area, the reason being found in leakage of the high-pressure inlet valves, whereby the intercooler pressure is raised.

Fig. 5 shows the inlet-valve area to be restricted. The intake line is drawn noticeably below the atmospheric line, whereby not only the volumetric efficiency is decreased but also more power is required to compress the air.

Fig. 6 is from a compressor with mechanically operated inlet valves, which occasionally give cards like this. It shows the inlet valves to be not properly adjusted. They have too much lap, i.e., they open too late and should be set to either open at the point where the reëxpansion curve intersects with the atmospheric line or a trifle earlier, hereby insuring a good card and good volumetric efficiency.

Resistance of Wood to Shock

Little study has been given to the resistance of wood to the action of impact loads, such as result when a locomotive passes over a wooden trestle. The Forest Service of the Department of Agriculture has been studying the subject at the timber-testing station at Purdue University, Lafayette, Ind., and finds that wood is more elastic under impact than under gradually applied loads. This would go to show the wisdom of locomotive engineers in taking a weakened trestle at high speed.

The maximum deflection under a gradually applied load was 1.2 inches, and the deflection just preceding failure under impact was 1.1 inches. There is, thus, little difference between the ultimate deflection of wood under the two kinds of loading. But at the elastic limit the average deflection under gradual loading was 0.33 inch, while the average deflection under inpact loading was 0.66 inch. Thus this wood possesses twice the elastic strength under impact that it does under static load.

ENGINEERING REMINISCENCES

"Graft" Experience with a Government Engineer—Experiment Showing the Differences in Temperature in the Tubes of a Boiler—The Cross-compound Engine a Success—Reasons for Failure at the Atlanta and Boston Expositions—Meddlesomeness of a Superintendent and Its Disastrous Consequences

BY CHARLES T. PORTER

I had a queer experience with an engine for the New York post office. It was to take the place of an engine then running. The engineer of the post office informed me that this engine had a cylinder twelve inches in diameter. I told him it looked to me from the external dimensions that the diameter must be fourteen inches and asked him to take off the back head and measure it for me. He wrote me a few days after that he found that he could not get the back head off but I might rely upon it being twelve inches. So I did rely upon it being fourteen inches, furnished an engine accordingly and found it to be the size needed.

A "GRAFT" EXPERIENCE WITH A GOVERNMENT ENGINEER

Some time after the engine was started I received a line from the postmaster saying they were much disappointed in it. They expected a gain in economy, but they were burning more coal than before, also that the engine pounded badly. I went to New York to see what the matter was. The engine seemed to be working all right except for the knock, so I made my way down to the sub-cellar. There was nothing there but the boilers and the engineer's desk. On the cellar stairs, after I had shut the door behind me, I heard a loud sound of escaping steam. The boilers were under the middle of the building; a four-inch steam pipe ran from them a distance of about eighty feet, suspended from the ceiling, to a point under the engine, then turned up through the floor to the under side of the steam chest. The exhaust pipe, of the same size, came from the engine through the floor and was carried parallel with the steam pipe to the middle of the building and upward through the roof. The two pipes were about eighteen inches apart, and in the vertical portions under the ceiling they had been connected by a half-inch pipe having a globe valve in the middle of its length. The valve-stem was turned downward and the valve set wide open. The noise I heard was caused by the steam rushing through this pipe. I computed that about as much steam was being thus blown away as was used by the engine. My first impulse was to call upon the postmaster and tell him what I had found, but decided not to bother him. I could not reach the valve to close it but discovered a box used for a step to an opening in the wall, so I brought that out and standing upon it was able to close the valve; then the noise ceased and I put the box back.

There was no one in the cellar but a boy firing the boilers. I asked him if he knew who put that pipe there. He knew nothing about it but supposed our men put it there when they set up the engine. I hunted up the engineer and asked him the same question, and got the same answer. I went to the people who did the engineering work for the post office and who put in the pipes; they knew nothing about it. I could find out nothing, but had to content myself with telling the engineer that I had closed the valve and relied upon him to keep it closed. I asked him what he thought caused the thump in the engine; he said he had not the slightest idea, but he would try to cure it. I contented myself with writing to the postmaster that I had removed the cause of the waste of steam and hoped he would now find the engine satisfactory. Soon after Mr. Merrick was in New York for two or three days. When he came home he said: "I have cured the thump in that engine." "How did you do it?" I asked. He replied: "I gave the engineer a twenty-dollar gold piece and when I went to see it the next morning the thump was gone." I should add that when the old engine was taken down I had the back cylinder head removed, which was done without difficulty, and found the diameter fourteen inches. "For ways that are dark and tricks that are vain" commend me to a Government engineer.

I had brought with me from Newark an order from the Willimantic Linen Company, who were manufacturers of cotton thread, for two engines for quite an interesting application. They were building a new mill entirely unique in its design. It was a one-story mill 800 feet long and 250 or 300 feet wide, intended to contain five lines of shafting. Each line was independent and drove the machinery for all the successive operations from opening the cotton bales to packing the spools of thread. These lines of shafting were to be in the basement and drive these machines by belts through the floor, the engine to be in the middle of each line. For this purpose I supplied a pair of condensing engines, 11 inches diameter of cylinder and 16 inches stroke, making 350 revolutions per minute with their cranks set at right angles with each other in the line of shafting. These required no fly-wheel and would start from any position. I had a great deal of trouble with this order on account of the delay in its execution, so much so that before the first engine was finished the order for the second one was countermanded and this order was placed with the Hartford Engineering Company, a new concern which was foolish enough to undertake the same speed. However, after my first engine was started they found themselves face to face with an impossibility and had to throw up their contract, whereupon the president of the company became very civil and asked me to be kind enough to make the second engine for them, which I was quite happy to do, as I had on hand the peculiar bed for these engines which I did not break up after the order was countermanded, but had it set up against the wall of the shop in readiness for what might happen. These two engines were both in successful operation when my own operations ceased; the remaining three engines were to be added as their business required.

EXPERIMENTS SHOWING THE DIFFERENCE IN TEMPERATURES IN THE TUBES OF A BOILER

The engineer of that company was an original investigator. He had a battery of return-tubular boilers each one crammed full of tubes according to the usual methods of boiler makers. He provided himself with pieces of lath one inch wide, one-eighth of an inch thick, four inches long and laid one in the front end of each tube in one of his boilers and left them there for twenty-four hours. He had made a diagram of his boiler on which he numbered every tube and put a corresponding number on every piece of lath. In taking them out they presented an astonishing revelation which he showed me. Some of the pieces were burned to a coal and some were scarcely discolored, while the great body of them presented various effects of heat between these extremes. These showed distinctly the enormous differences in the temperature of the gases passing through the different tubes, and that fully one-half of the tubes did little or no work in evaporating the water. They taught a lesson which boiler makers, who count every additional tube they can get into a boiler as so much added heating surface and rate their boilers accordingly, have no anxiety to learn, but which I afterward turned to good account, as will be seen.

THE CROSS-COMPOUND ENGINE A SUCCESS

About the last and the most interesting engine that I built while in Philadelphia was one for the firm of Cheney Brothers, silk manufacturers, of South Manchester, Conn. This was a cross-compound, the first and the last compound engine that I ever built, and it is the only engine in this country to which I applied my condenser. The cylinders were 12 and 21

inches in diameter, the stroke 24 inches, and the shaft made 180 revolutions per minute. The condenser presented a new design in that the air-pump was double-acting and made only 45 double strokes per minute, being driven by a belt from the engine shaft and the motion reduced by gears 1 to 4. This engine ran perfectly from the start and I looked forward with confidence to a demand for many more of the same type. The diagrams made by it are reproduced herewith.

I have a pleasant memory connected with this engine. The silk mill is located in a very large park, scattered in which are the residences of different members of the family. About twelve years after the engine was built, in company with my wife, I was visiting relatives in Hartford, from which South Manchester is about twelve miles distant. One day we were driven over there with our friends to make a social call. On our arrival I left the party to make a visit to my old engine. The mill seemed to have been changed very much and I lost my way. Finally, I recognized, as I thought, the old engine room and went in. My engine was not there but in its place stood another engine, a pair of tandem compounds of much larger dimensions. These had evidently just been erected, as they stood idle. "Oh dear," said I to myself, "my engines have been superseded for some reason or other." While I was indulging in that reflection the engineer came in; I introduced myself and said to him: " I see that my old engines have been supplanted." "Oh, no," said he, "your engines are all right; they are running just where they always did. They have built a new mill twice as large as the old one and your engines have been giving such satisfaction, they have ordered another pair of compounds from the Southwark Foundry, and these are the engines; they have not been started yet as the mill is not ready for them and won't be for a month."

He directed me to the old engine room, where I found my engines gliding away as silently as though they were erected yesterday. I experienced a singular revulsion of feeling, and confess to deep emotion when I thought of what might have been.

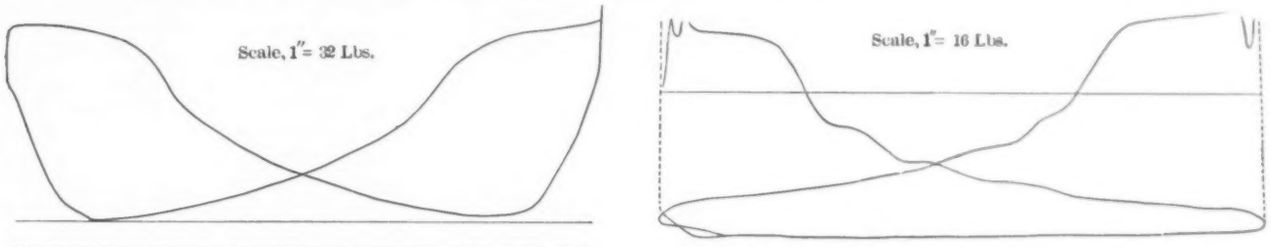
DISAPPOINTMENT AT THE ATLANTA EXPOSITION

In the spring of 1881, in our anxiety of revive the manufacture of the engine, we were foolish enough to send one to the Atlanta exhibition. We eagerly believed the promises of the agent that we should find all the machinery that we wanted to drive, and sent an engine 12x12 inches and a skilful man to erect and run it. We also printed the heading of a great lot of diagrams, to be given to visitors. The facts were found to be that we had nothing to drive but an idle line of shafting and one Clark's spool winder, while the exhaust main was so small and choked with the exhausts from other engines that we had a back pressure of ten pounds above the atmosphere; so we could take no diagrams; and the fact that we did not take any was used as a conclusive argument against high-speed engines; so the exhibition did us harm instead of good.

FAILURE AT THE BOSTON EXHIBITION AND ITS SUPPOSED CAUSE

Another exhibition opened in the fall of 1881, for which I made great preparations, and from which I anticipated important results. This was the exhibition of the New England Merchants' and Manufacturers' Association, held in Boston. I obtained an important allotment of space with plenty of machinery to drive, and, besides a fine engine, sent a large exhibit of our finished work, in the parts of several sizes of engines, expecting to attract the attention of all New England manufacturers. I prepared for a regular campaign. I rented an office and engaged a young man to represent us in Boston as our agent, and another to travel and solicit orders and take the charge of erecting engines. When we came to put the engine together in the exhibition, the piston would not enter the cylinder. On examination it was found to have been turned conical, the bases of the two cones meeting in the middle, so the middle was one-eighth of an inch larger in diameter than the faces. We had to get a coarse file and file down the middle of the piston all around until it would enter the cylinder. Then I had a great disappointment—the greatest I ever experienced—the engine thumped badly on both centers. The only way in which we could stop the thumping was by shutting off the steam until the initial pressure was brought down to the hight reached by the compression of the exhaust. In this plight we had to run through the exhibition. We could not take a diagram and had to watch the engine constantly, for whenever the pressure rose ever so little too high in the cylinder it would begin to thump. I attributed this to the shocking condition of the surface of the piston. I could not comprehend how this should cause the thump, but it must be that, for I could conceive of nothing else that could produce it. It made my exhibition a total failure, and necessitated the abandonment of all my plans.

At the close of the exhibition I went home utterly discouraged. When I went into the shop the first person I met was the foreman of the lower floor, where the engine had been built. I told him of the plight in which I found myself placed and to which I attributed my failure. The fellow gave me the lie direct, saying with a conceited smirk: "It is impossible, Mr. Porter, that any such work as you have described can have gone out of this establishment." I turned on my heel and left him, and in less than half a minute, I saw at a distance of fifty feet a 22-inch piston being finished for an engine we were building for the Tremont and Suffolk Mill. The workman had finished turning the piston and was then cutting the grooves for the rings. The reflection from the surface showed me the same two cones meeting in the middle. I went up to the lathe, the backside of which was toward me, and told the workman to stop his lathe and bring me a straight-edge. This rocked on the edge in the middle of the piston, opening nearly one-eighth of an inch on each face alternately. I sent a boy to find the foreman and asked what he thought of that and left him. I had influence enough to have both the foreman and the workman discharged that night. Think of it; superintendent, general foreman, the foreman of the floor and workman, altogether, never saw what I detected at a glance from the opposite side of the shop.



DIAGRAMS FROM MR. PORTER'S FIRST AND ONLY COMPOUND ENGINE

I want to stop here to express my disgust with the American system of making the tail-stock of a lathe adjustable, which enables either an ignorant, careless or malicious workman to ruin his work after this fashion. To their credit, English tools have no such feature.

A MEDDLESOME SUPERINTENDENT MAKES DISASTROUS CHANGES IN MY PLANS

The next day a young man called from the works of Russell & Irwin at New Britain, Conn., to tell us that their engine just put in by us had a very bad thump which he was afraid could not be cured as it was

evidently caused by the piston projecting over the admission ports when at the end of its stroke. "Impossible," I exclaimed, "I never made such an engine in my life." I should here state that in experimenting with the first little engine that I made before I went to England, I at first made the piston project over the port one-quarter of an inch and the engine thumped. I satisfied myself that this was caused by the impact of the entering steam against the projecting surface of the piston driving it against the opposite side of the cylinder; this was aggravated in high-speed engines.

In this case the engine made 160 revolutions per minute and the steam was admitted through four simultaneous openings, so it entered the cylinder with great velocity. I turned a quarter of an inch off each face of the piston and the thump disappeared. I then made it a law from which I never varied, that the piston should come to the admission port and not project over it all, and this feature was shown in every drawing. The young man replied to me: "It does project, Mr. Porter, it projects seven-eighths of an inch over the port at each end of its stroke, for I have measured it." I rushed up to the drawing office and called for the drawing of that cylinder and there I saw the piston not only drawn but figured projecting seven-eighths of an inch over the port. I felt as though I were sinking through the floor; that was what had ruined my Boston exhibition and sent me home disgraced and broken-hearted, and the badly fitting piston, shameful as that was, had nothing to do with it. The first question that occurred to me was: "How came this drawing to exist and I to know nothing about it?" The answer to this question was simple.

When the first pair of Willimantic engines was started, I was disappointed in their economy, and made up my mind that the excessive waste room was accountable for it. The proportion of cross-section area to the stroke being fifty per cent. greater than in my table of sizes increased in the same degree the proportion of waste room to the piston displacement. I felt that there was need here for improvement. By far the greatest amount of waste room was in the exhaust ports. I accepted a modification of the exhaust valves by which this item of the waste room was reduced fully one-half and made a new pair of cylinders for this engine. The improvement in the economy was so marked that I determined to change the exhaust valves of all the engines; only the exhaust valves and ports needed to be changed. These were drawn anew in pencil and carefully studied and approved of by me. It was necessary that the entire combined cylinder drawing should be retraced, but this, except only the exhaust ports and valves, was copied over the existing tracings. This did not require my attention, and I gave no thought to it. Here was the superintendent's opportunity. In copying these tracings he had only to move the straight line representing each face of the piston on the longitudinal section of the cylinder seven-eighths of an inch, adding this amount to the piston at each end and shorten the cylinder head to correspond, and the job was done, and there did not exist among the large number of persons in the drawing office and shop who must have been aware of this change, loyalty enough to let me know anything about it.

We had also recently finished two engines for the Cocheco mill at Dover, N. H., and about this time we received a letter from the superintendent of that mill expressing his admiration of the engines in every other respect, but complaining of a bad thump in the cylinder. He said he would be glad to invite the superintendents of other mills to see them, but he could not show the engines to anybody until that thump was cured.

ASKED TO RESIGN

I went directly to the president and demanded authority to change the pistons and heads of these engines. To my astonishment he refused point blank, saying he had spent money enough on these alterations; and he would not spend another cent. I replied to him that there was one other alternative and that was to abandon the business, to which he made no reply. But why did I need to go to the president, why not make these changes myself? The answer to this question is very humiliating to me. An account had been made up of the cost of the alterations here described and presented to the board of directors, showing this to amount to $20,000. I was aghast at this statement; I never saw a figure pertaining to the business, except the single bill already mentioned. I told the directors that any good pattern-maker would have taken the contract to alter those exhaust valves and ports on our twenty sizes of cylinders for an average price of fifty dollars each, and made a profit of fifty per cent. in doing it. The cost of the new drawings and the price of cylinders for the Willimantic engine could not more than double this sum, and by some hocus-pocus this $2000 had been changed to $20,000. The president replied that was the cost of the alterations as it appeared in the books, and the directors adopted a resolution that no further alterations should be made unless expressly ordered by the president.

I did not believe that in making this addition to the length of the piston the superintendent had any intention to wreck the business. He could have had no idea of its fatal nature; his only thought was to make a considerable further reduction of waste room and gratify his itching to change my drawings. But, of course, doing this without my knowledge was criminal, and should have caused his instant discharge; but his whole conduct from the beginning had been the same and the president had sustained him. I had no opportunity to press this matter further. On receiving the president's refusal, I determined to appeal to the directors, but first I thought I would lay the matter before Mr. Henry Lewis whom I regarded as the most open-minded of all. What was my amazement when after listening to my statement he replied: "We shall sustain the president, Mr. Porter." Then I knew the end had come. A day or two after, a committee of the directors, headed by Mr. Shortridge called at the office and asked to see our order book. This showed that in more than a month preceding we had not received a single order. On this state of affairs it was evident to the directors that a change must be made in the management. I had long realized that the great gulf that I had dug between the stockholders and myself, as already described, had never been filled. Neither the directors as a body, except on the single occasion already mentioned, nor any director individually, had ever conferred with me on any subject whatever. They knew nothing, except what they might have learned from the president; he had no mechanical knowledge or ability to form a mechanical judgment. In the firm of Merrick & Sons, he had been the office man; he was entirely a man of routine, and wedded to the past, and the superintendent influenced him in a degree which to me was unaccountable. His want of comprehension of the business was shown in his answer to the life or death question which I had presented to him. The next day I received a communication from the directors requesting me to send in my resignation, which I promptly did. Mr. Merrick was also requested to resign; he had for some time expressed a wish to be relieved from his position, which he found very uncomfortable.

THE BUSINESS RUINED—ITS REORGANIZATION

The directors elected as president one of their own number, who had nothing else to do, to sit in the president's chair and draw his salary, and committed the practical management of the business to an oily-tongued man who had never seen a high-speed engine, and whose qualification for the position was, that he was a friend of one of the directors. This arrangement lasted a year. When at the end of that time this man was asked why he had done nothing at all, he replied, as I was told, that he had spent all of his time going about the country "trying to cure Mr. Porter's blunders." In the course of four or five years the company had got rid of all its capital and of $500,000 raised on a mortgage, and was $175,000 in debt. In this emergency they invited James C. Brooks, then a member of the firm of William Sellers & Co., to take the presidency of the company. He told them if they would raise $250,000 by the issue of preferred stock to pay off the indebtedness and leave

him $75,000 to start with, he would see what he could do, and by his combination of engineering skill and business ability the business soon entered into the career of prosperity, which under his management has continued to the present time.

I will close this account of my engineering career by relating two incidents.

Some time after I left, the company found that they needed a descriptive and illustrated catalog of the business, and they had no one to write it; so they came to me and in my office in New York I prepared one for them, for which they gave me the credit by printing on the title page and cover the line "By Charles T. Porter."

CONSEQUENCES OF NOT HARDENING A CRANK PIN

Among the orders which I brought from Newark was one from B. F. Avery & Sons, plow manufacturers, of Louisville, Ky. Mr. George Avery, one of the sons, had come to me and asked for a list of the engines I had running, and took the pains to visit a large number of them, also those of other prominent builders, and as a result of this extended comparison he brought me his order for an 18x30-inch engine, with strong expressions of the manifest superiority of the high-speed engine. This engine was about the first one I finished in the Southwark Foundry. By great carelessness it was permitted to go out without the crank-pin being hardened and ground, which was contrary to my invariable practice. The man who erected the engine left the crank-pin boxes too loose and Mr. George Avery, who was quite an amateur mechanic, undertook to tighten them up; he succeeded in heating the pin and causing it to be badly cut. He made the best job of it that he could with a file, and the engine ran in that crippled condition.

Some time after I had left Philadelphia, they concluded they ought to have a hardened crank-pin and wrote to the Southwark Foundry respecting it. They received a reply that it would be necessary to take the shaft out and send it to Philadelphia, and their works would be interrupted about three weeks. The firm then wrote to me in New York asking me to come to Louisville and examine the engine and advise them what to do, which I did. The letter to the Southwark Foundry had been written by their manager, a Mr. Coen, and in it he stated that the engine pounded so badly that it could be heard two blocks away; it was so wasteful it was almost impossible to keep up steam for it, and that they lived in such dread of its breaking down that their hair was all turning white. I felt that this letter reflected pretty badly, not only on the engine, but also on the boilers. These were two return-tubular boilers which I had designed myself. I had long felt that tubular boilers needed a better vertical circulation. This was limited by the small space left for the descending currents so I allowed a space five inches wide between the shell of the boiler on the sides and bottom and the nearest tubes, as it was evident to me that the water, filled with bubbles of steam, would rush up among the tubes fast enough if it could only get down at the sides. I also left off the upper row of tubes to allow more space above them for both water and steam, and from this arrangement I anticipated very superior results.

On my arrival in Louisville, I thought, before presenting myself at the office, I would go into the works and see what the state of affairs really was. I was directed to the boiler house, on entering which I saw that one of the boilers was idle. My first thought was that it was disabled by some accident and their being limited to one boiler accounted for the difficulty they experienced in supplying the engine with steam. I asked the fireman what had happened to put this boiler out of commission; he said: "Nothing at all. They used both boilers at first but after a while they thought they did not need both, so they shut one down and it has been shut down ever since." "Well," said I, "you must have to fire pretty strong to make one boiler answer." "No," said he, "I have been firing boilers over twelve years and this is the easiest job I have ever had." He then showed his thin fire and damper more than half closed, so I gave Mr. Coen credit for one good square lie. I asked the way to the engine room; he told me, "Right through that door." I listened for the pound that could be heard two blocks away and heard a faint sound. On opening the door, which was opposite the crank, it was more distinct. There was no one in the engine room, but while I was looking the engine over the engineer came in. I introduced myself and asked how the engine was doing. He said, "Very well, all but that little knock in the crank-pin." I asked him if he had any trouble with it; he said, "None at all." "No worry or anxiety?" "Never thought of such a thing," he said.

A number of years after, I met a young gentleman in New York who had been in the office of Avery & Sons at that time. I told him this story. He said he was not at all surprised; the boys in the office heard this manager every day dictating letters just as full of falsehoods as this one. I learned afterward that this Mr. Coen held his position through a cabal in the company, and that soon after I was there the president succeeded in getting rid of him.

I was now ready to call on the president, Samuel Avery; he told me they would like very much to have a hardened crank-pin put in the engine, but of course they could not afford to interrupt their work for that purpose; I replied there would be no difficulty about that. I would design a screw-press by which the present pin might be pressed out and a new one inserted in a few hours; all our work being made to gages, the new pin would be sure to fit. I told him he might safely send an order to the Southwark Foundry to make the press which I would design, and the new pin, if they would agree to put the work into the hands of E. F. Williams, a mechanical expert in whom I had confidence, who should direct the manufacture of the press and pin and who would himself go to Louisville and do the job. The Southwark Foundry agreed to these conditions, and the work was soon done.

After the plow works had stopped at night Mr. Williams pressed out the old pin, first chipping off the riveting, pressed in the new one and rebabbitted and adjusted the boxes, and in the morning the engine started running silently and continued afterward to be the object of unqualified admiration.

Legal Notes

BY E. P. BUFFET

POWER EQUIPMENT AS FIXTURES

Fixtures are property, in nature personal, but so annexed to, or used in connection with the realty as to raise a question whether they are to be treated as personal or real. This question comes up when the land changes hands. It is apt to arise concerning power equipment placed in a building which has to be vacated by reason of sale, expiration of a lease, foreclosure of a mortgage, or the like, necessitating a decision what the party who moves out is entitled to take away with him. There are various tests used to determine this matter, such as the intention in placing the chattels there; the relation of the parties, whether landlord and tenant, vendor and vendee, mortgager and mortgagee, etc.; the character of physical annexation to the realty; and public policy, involving the question of good faith. Then too, precedents have arisen as to the status of particular classes of articles, such as gas "fixtures," which legally are not fixtures at all, but pure personalty, the vendor of a house being privileged to remove them in default of stipulation to the contrary. Such is the law in many States.

Where the appliances were put in by a party whose occupancy seemed at the time being permanent in character, the presumption, other things being equal, is that he intended them to stay there as part of the realty. This principle as applied to the rights of mortgager and mortgagee works out in favor of the latter. Essentially that relation subsisted between the parties to a recent case in New Jersey Chancery. The goods in question were some equipment of a Newark chemical factory, including a steam engine, with lighting generator and accessories; steam engine with piping and shafting, to supply

power; two freight elevators; a power pump and two steam pumps. The receiver of the mortgager company had removed these from the factory and sold them as personalty. It is decided, however, in connection with the foreclosure suit, that compensation for their removal must be made to the mortgagee. We cannot here enter into all the tests applied by the vice-chancellor in coming to this conclusion. It may be remarked, however, that he had the most doubt about the status of the pumps, which, whether from the nature of their use in this case, or of their foundations, or otherwise, he regarded as somewhat different from that of the rest of the equipment named.
64 Atl., Rep., 694.

ONLY REASONABLE FORESIGHT REQUIRED

An employer may be exempt from the obligation to give warning of a danger if that hazard is of such peculiar character that failure to foresee it does not constitute negligence on his part. An illustration occurs in a well-known Philadelphia machine shop. There was a shaft which transmitted power from one building to another and upon it a collar with projecting set-screw. This was sixteen feet above the floor, quite out of harm's way under ordinary conditions. A carpenter who had built a scaffold claims that he was injured by his clothing catching in the screw. He testifies that it was too dark for him to see it. It appears that he was not sent into the building to do any work on the shaft, or upon anything connected with it, although he had taken down a countershaft in the course of his work. The belting had been detached from the shaft in that building and none of the machinery was operating there. The shaft would have been stopped except for its connection with the adjoining building. The man recovered judgment in the Court of Common Pleas, but this has been reversed by the Supreme Court. It is there held unreasonable that the employer should be expected to have anticipated the singular accident so as to give warning of the risk.
64 Atl. Rep., 370.

LIMITATION OF DUTY TO WARN

A boy of fifteen operating a punch press failed to remove his foot from the treadle so as to stop the plunger, and consequently it injured his hand. He had not been told in so many words to remove his foot from the treadle as a matter of safety, but he had been shown that this was the way to operate the machine, and he knew that pressure on the treadle opened the clutch, and that while the latter was open the plunger would continue in motion. The Supreme Court of Pennsylvania holds that he had been sufficiently instructed and knew his business and that the employer is not liable for not having warned him more specifically against so obvious a danger.
64 Atl. Rep., 703.

A COMPARISON OF FOUR-CYCLE GASOLENE ENGINES AS USED IN AUTOMOBILE SERVICE

BY E. J. BARTLETT

The use of multiple-cylinder engines as a motive power for automobiles has increased as the automobile industry has become generally recognized as one commercially important. Aside from the pleasure some may derive from driving a car with a cylinder or two more than that of their neighbor there is a reason for this tendency to increase the number of cylinders with the extra cost and the many attendant parts to keep in adjustment and repair; otherwise the multiple-cylinder engine would now be a novelty rather than the prevailing practice.

The advantages gained by an increased number of cylinders are, first, a greater power than can be developed from a single cylinder of practical size; second, a more steady application of this power; and third, a reduced vibration. The results of a combination of these features are seen in the comparatively silent, powerful and smooth-running cars of the present time.

If the motions of a reciprocating engine were uniform, and if the power was developed evenly there would be no special attention needed to obtain a balanced unit. Unfortunately, however, such is not the case; the piston does not travel as fast during the inner half of the stroke as it does during the outer half, nor is the acceleration during either half stroke uniform. Neither is the power developed uniformly in a four-cycle engine such as we are considering. There is but one impulse in every two revolutions of the crank shaft and a considerable portion of the power developed during the power stroke is absorbed by the engine in the three following strokes of exhaust, suction and compression.

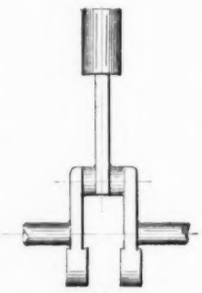


FIG. 1

SINGLE CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

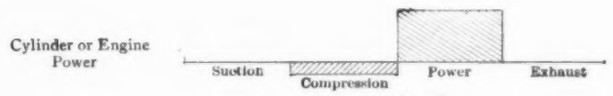


FIG. 2

Various types of engines, composed of different combinations of cylinders, have been placed on the market, but only the most common and those of most importance commercially will be considered in this article. The simple diagrams show, graphically, the arrangement of the reciprocating and revolving parts and the relative steadiness of the power developed by each type. It should be understood, however, that the power diagrams are elementary illustrations only, as no account is taken of the power absorbed by the suction and exhaust strokes, nor do the diagrams represent, except roughly, the relative values of the compression losses, represented below the base lines, and the power impulses, above the base lines, the shaded compression areas simply representing a less amount of power than the shaded impulse areas. For convenience the inlet opening and exhaust closing points are assumed to be on the crank centers and the intensity of pressure uniform throughout the strokes. The approximate relative balance and torque conditions in these types of engines are then shown at a glance, which would not be possible in an exact mathematical study of the kinetics of such explosion engines. The unbalanced inertia effect referred to, due to the variable speed of the piston, will not be considered further in this discussion as it is present in all types of reciprocating engines.

THE SINGLE-CYLINDER ENGINE

When the gas, resulting from a proper mixture of air and gasolene, is compressed in the end of the cylinder and then ignited the volume is suddenly and enormously increased, resulting in a pressure which forces the piston downward or inward, for the distance of the stroke. The piston, being connected to the crank by means of the connecting rod, revolves the crank one-half revolution or 180 degrees. This is the power stroke. An equal and opposite pressure is at the same time exerted against the end of the cylinder, tending to lift it up or out. This pressure, or shock, is communicated through the engine-supporting mechanism to the car, and its occupants and, if the cylinder be large and the shocks heavy, the jar is pronounced and disagreeable.

The moving parts also have their motions suddenly arrested and reversed at the end and beginning of each stroke, as the reciprocating motion of the piston, piston pins and piston end of the connecting rod is converted into a revolving motion of the crank-pin end of the connecting rod, crank pin, crank webs and crank shaft.

The rotating parts may easily be balanced by attaching properly proportioned counter-weights to the opposite side of the crank shaft, but the reciprocating parts can only

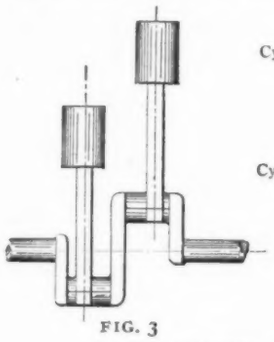


FIG. 3

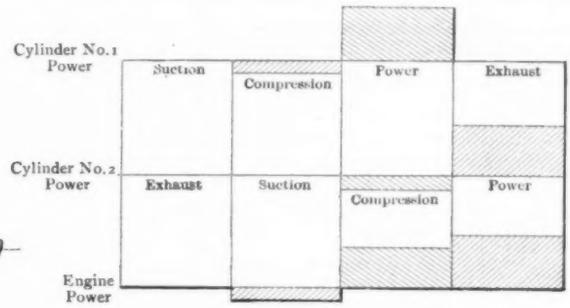


FIG. 4

TWIN-CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

be balanced by similar parts acting in the opposite direction, which for mechanical reasons is impractical in this type of engine. For these reasons the size of a single-cylinder engine is limited by its vibrations.

Referring to the power diagram shown in Fig. 2 the first stroke or half revolution of the crank shaft is approximately idle; during the second stroke power is actually absorbed by compression; the third is the power stroke, and the fourth is also approximately idle. It is thus seen that only one stroke in four is productive of power and the movement of the crank shaft fluctuates. A heavy fly-wheel materially reduces this fluctuation by absorbing energy during the power stroke and giving it out during the other three strokes of suction, compression, and exhaust. A wheel of practical weight, cannot, however, entirely eliminate this jerky movement. Whether the engine is vertical or horizontal determines the direction of this vibration and the slower the speed of the engine the more jerky the movement as a longer idle period results. The single-cylinder engine is therefore best adapted to run at a moderately high speed and the permissible size makes it most popular for light cars.

THE TWIN-CYLINDER ENGINE

This type of engine is developed by placing two cylinders side by side on a ocmmon crank case or base and communicating the power developed to the same crank shaft. Two crank arrangements for twin-cylinder engines have been used, giving either balanced reciprocating parts and irregular explosions or unbalanced reciprocating parts and regular explosions. Either type is but little used at present, but their action is interesting to note. The first arrangement has the cranks upon which the pistons respectively act placed on opposite sides of the crank shaft. The reciprocating parts thus always move in opposite directions and are balanced as shown in Fig. 3. One cylinder is always compressing or exhausting while the other is drawing its charge or exploding. The explosion or power strokes occur at two successive half turns of the crank shaft and, as is seen by referring to the power diagram, Fig. 4, not only is no power developed during the next two half turns, but the latter stroke actually absorbs power for compression already stored in the fly-wheel. The diagram also shows the combined power the cylinders develop and it will be noted that the second cylinder de-

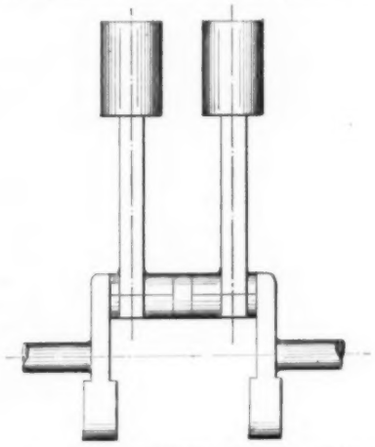


FIG. 5. TWIN-CYLINDER CRANK ARRANGEMENT WITH CRANKS ON SAME SIDE OF SHAFT

livers more power to the crank shaft during its power stroke than does the first, for the first is not compressing during the stroke.

In the second crank arrangement, Fig. 5, the cranks on which the power developed is applied are on the same side of the crank shaft. The reciprocating parts always move in the same direction and, are, therefore, unbalanced. The suction and power strokes in one cylinder take place during the power and suction of the other and the exhaust and compression strokes in the cylinders are always opposed. The power diagram is exactly the same as for the double opposed-cylinder engine next described.

As in the case of the single-cylinder engine the rotating parts may be balanced by counter-weights and the fluctuations decreased by the rise of a heavy fly-wheel. This wheel may be somewhat lighter with the last crank arrangement noted than with the first, and both arrangements require less fly-wheel effect than the single-cylinder engine owing to there being fewer idle strokes.

The vibrations due to the explosions in the cylinder are less than in a single cylinder of the same power, as the power strokes are one-half as powerful and occur twice as often. In fact it may be said that the steady action of any multiple-cylinder engine depends largely on the force of the individual power strokes and their frequency.

THE DOUBLE OPPOSED-CYLINDER ENGINE

If two cylinders are placed opposite each other and joined to a common crank case and transmit their power to cranks on opposite sides of the crank shaft as shown in Fig. 6, the double-opposed-cylinder type of engine results. As this construction makes a long engine it is mounted in a horizontal position either longitudinally, under the body, or crossways of the frame and in front. In either position it is the most practical type of two-cylinder engine, and is widely used owing to its mechanical balance and comparatively even torque development. Reference to the cut shows the pistons always moving in opposite directions and therefore the reciprocating parts are balanced and the revolving parts, being symmetrical, are also balanced. The outward strokes are, therefore, either compression or exhaust and the inward strokes power or suction. This means that during one-half turn of the crank shaft the first cylinder draws its charge and the second cylinder has its power impulse; in the next half stroke they compress and exhaust their charges respectively; the next half is

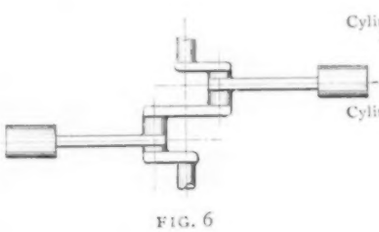


FIG. 6

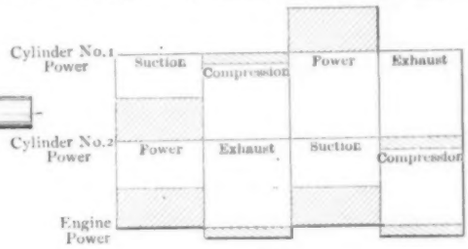


FIG. 7

DOUBLE-CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

power and suction; and the last half exhaust and compression. This is plainly shown by the power diagram, Fig. 7, which also shows the combined impulses of the cylinders to be uniform with alternate power and compression periods.

This type is seen to combine the advantages of both twin-cylinder types in regard to balance and even torque and a lighter fly-wheel is required to give the same results. For medium weight and priced cars it may be regarded as a standard construction.

THE TRIPLE-CYLINDER ENGINE

The triple-cylinder engine results if three cylinders are set side by side and joined to a common crank case and deliver their power to the same crank shaft. If the cylinders are of the same capacity the only crank arrangement approaching perfect balance is where the cranks are evenly spaced around the shaft or 120 degrees apart. The reciprocating and rotating parts are then practically balanced, as is shown in Fig. 8. When No. 1 piston is at the end of its stroke, the other two cranks stand at 120 degrees to it on opposite sides.

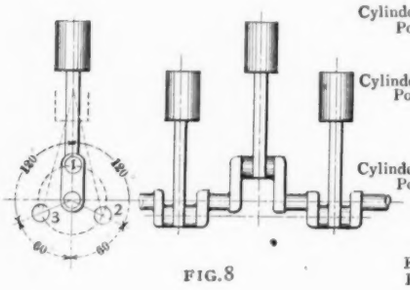


FIG. 8

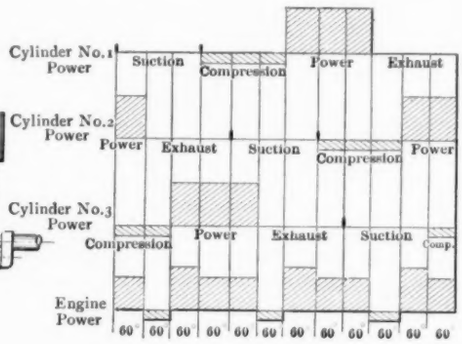


FIG. 9

TRIPLE-CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

To trace the action of the engine the power diagram, Fig. 9, must be carefully followed. During the suction stroke of No. 1 cylinder its crank revolves 180 degrees. No. 2 crank revolves 60 degrees, completing its power stroke and 120 degrees of its exhaust stroke. No. 3 crank revolves 120 degrees, completing its compression stroke and 60 degrees of its power stroke. The next stroke of No. 1 is its compression stroke, during which No. 2 completes its exhaust and 120 degrees of its suction stroke, and No. 3 completes its power and 60 degrees of its exhaust stroke. Then follows the power stroke of No. 1; the completion of the suction and 120 degrees of the compression stroke of No. 2; the completion of the exhaust and 60 degrees of the suction stroke of No. 3. No. 1's next stroke is exhaust; No. 2's, the completion of its compression and 120 degrees of its power stroke; No. 3's the completion of its suction and 60 degrees of its compression. It is thus seen that a continuous overlapping of strokes takes place with 60-degree intervals between similar strokes. In other words, power is developed, during three-fourths of the time at evenly spaced intervals. This results in a correspondingly light fly-wheel requirement.

Theoretically this type of engine would seem to deliver a torque quite steady enough for practical purposes and it does in the few engines manufactured. Thus far, however, manufacturers seem to regard it as intermediate between the cheap and fairly satisfactory double-cylinder opposed, and the more expensive and desirable four-cylinder engines and pass it by, building either one or the other of these types. Some claim that if one cylinder should fail to work properly, as might happen, a very unbalanced action would result, which is no doubt true.

THE FOUR-CYLINDER ENGINE

This type of engine is the standard of best automobile practice, and its action is easy to understand. The four cylinders are set side by side and joined to a common crank case delivering their power through the respective cranks to the same crank shaft. The universal crank arrangement is to place the end cranks on the same and the center cranks on the opposite side of the crank shaft. The rotating and reciprocating parts are then balanced, and since there are two revolutions and four strokes to a complete cycle the four cylinders have a different stroke at the same time, and the action is uniform, resulting in practically a continuous torque. The arrangement of the moving parts, and the regularity of action are shown by referring to Figs. 10 and 11. Since there are no idle periods to overcome, a light fly-wheel may be used, and the engine be throttled down to a slow speed, making it very "flexible" in action. Its complications are its principal disadvantages.

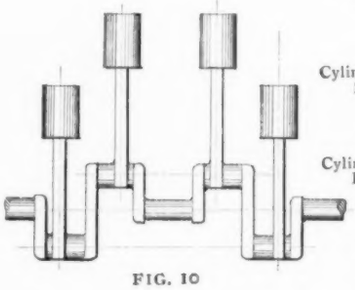


FIG. 10

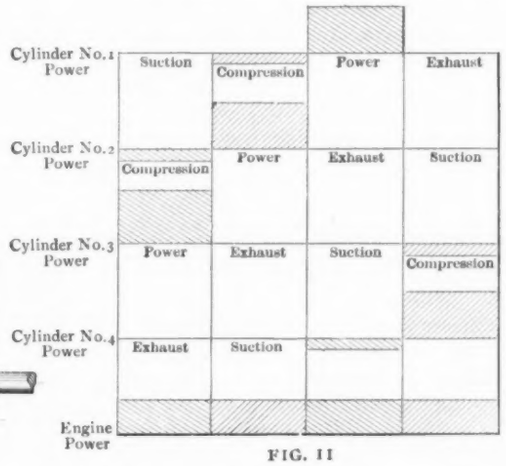


FIG. 11

FOUR-CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

THE SIX-CYLINDER ENGINE

This type of engine is a new comer in the automobile field, and one which bids fair to attain considerable importance. During the past season at least three American manufacturers have placed cars equipped with six-cylinder engines on the market and other manufacturers are said to be at work on similar cars for their next season's product. These engines have been produced to meet the demand for still greater flexibility than is attained by the four-cylinder engine. The use of the somewhat unsatisfactory speed changing mechanism is thus minimized. In fact one European manufacturer of six-cylinder cars offers, as an optional equipment, a "gearless" car.

There are two arrangements of six-cylinder engines. The first consists, essentially, of three double-opposed horizontal engines connected to the same crank shaft. The opposing cylinders deliver their power to the same crank, so there are three cranks spaced 120 degrees apart. This description, together with those already given for the double-opposed cylinder and triple-cylinder engines, will make the action of this engine plain.

The other and more common arrangement is with the cylinders vertical and each delivering its power to a separate crank on the same shaft. The cranks are spaced 120 degrees apart, except the two center ones, which are in the same plane. In effect the six-cylinder crank shaft is composed of two three-cylinder crank shafts. Fig. 12 shows the arrangement clearly. The reciprocating and rotating parts are balanced as in the triple-cylinder engine previously considered.

Since each stroke is of 180 degrees an-

gular movement of the crank and similar strokes in the different cylinders are 120 degrees apart, each stroke overlaps the preceding similar stroke by 60 degrees. Referring to the combined power of the engine represented in the power diagram, Fig. 13, it is seen that alternate periods of 60 degrees each exist in which there is either one cylinder developing power and two absorbing it in their compression strokes or two cylinders developing power and one cylinder absorbing it. The diagram exaggerates the pulsations which necessarily exist in this type of engine and which are not found in the four-cylinder engines. A greater proportion of the total power may, however, be called into action at any time and the engine is therefore more flexible.

OTHER ARRANGEMENTS

As was stated at the beginning of this article only the most common types of engines have received attention. A few more may be mentioned, however, to make the subject more complete.

At least one American manufacturer is building revolving engines of three and five cylinders. Another builds a triple-cylinder engine with the center crank on the opposite side of the shaft from the end cranks. The center cylinder is larger than the other two and uses their exhaust for its power.

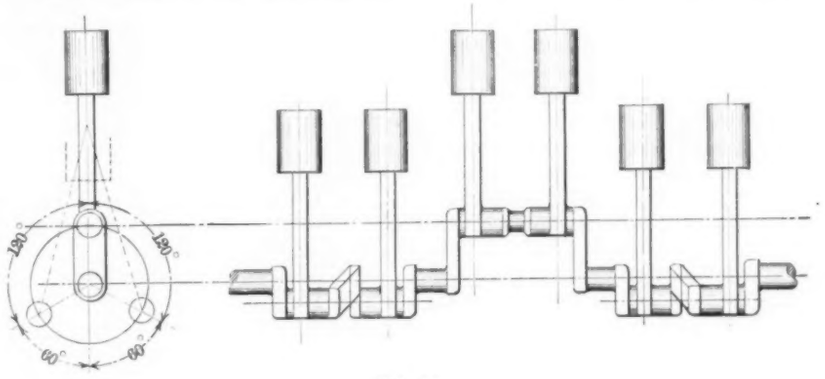


FIG. 12

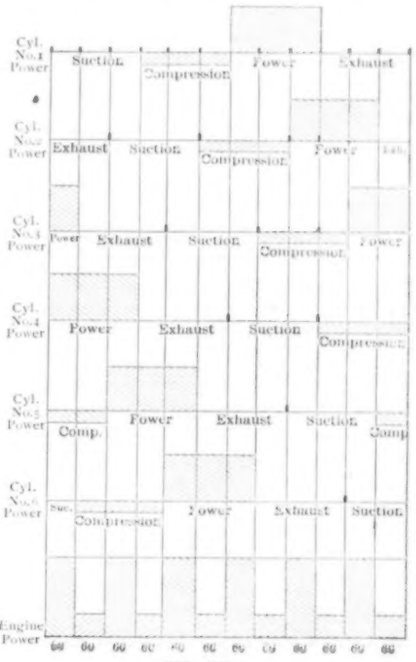


FIG. 13

SIX-CYLINDER CRANK ARRANGEMENT AND POWER DIAGRAM

Five-cylinder engines are not unknown, although they are very few. In this type the cranks are arranged 120 degrees from each other and if the center cylinder is twice as powerful as the others, a good balance results.

Eight- and even twelve-cylinder engines for racing cars have been exploited, but are not offered commercially.

The "V" type of engine has also been built. The cranks are set 90 degrees apart, each cylinder inclining 45 degrees from the vertical.

Locomotives propelled by compressed air are used, according to the *Indian Textile Journal*, in the Southern States of America" for hauling cotton to the coast, to avoid setting the cotton on fire by sparks, one of these locomotives hauling several thousand bales of cotton.

A PLAN TO PROVIDE FOR A SUPPLY OF SKILLED WORKMEN*

A Shop in which a Business is made of Systematic Instruction of Apprentices

BY MAGNUS W. ALEXANDER

Seven years ago, at the annual meeting of this society, Milton P. Higgins, of Worcester, Mass., analyzing the industrial situation of that time, pointed out the significance of the lack of competent mechanics. He sounded the note of warning that unless the educational system should provide as efficiently for the training of the future skilled mechanic as it now provides for the training of those who will ultimately become leaders in industrial occupations—engineers, superintendents, and managers—there would arise a serious handicap to the development of American industries. The paper aroused much interest and provoked a helpful discussion, and the ideas set forth were echoed in the technical press and reiterated in educational circles.

American industries, in the meantime, have developed at a tremendous pace, and their character has undergone significant changes. Specialization has become the American watchword and the spirit of it has permeated all branches of industrial activity. While specialization in manufacture on a large scale naturally tends to lessen the demand for all-round skilled artisans, yet on the other hand, the enormous expansion of modern industries requires a greater aggregate of skilled mechanics today than it did a decade ago; and, moreover, the degree of skill needed on account of the specializing processes and the highly complicated specializing machinery has been materially advanced.

Are we sufficiently supplied with mechanics who answer these present-day demands? Evidently not; otherwise the industrial training of the masses for positions at the bench and at the machine would not be such a burning question as it is today. The great amount of discussion and printed matter on the subject, the organization of committees for the study of the problems, and the appointment of State commissions, such as the Massachusetts Commission on Industrial and Technical Education, all illustrate the vital interest of the people in this question.

The admonition of Mr. Higgins, it seems, has not produced the desired results; and it is incumbent upon us to inquire into the cause. Trade schools of many kinds have been started in different parts of the country, and industrial training has been further developed in the public school system, yet we find ourselves face to face again with the fact that the further expansion of the industries, especially in the mechanical trades, is endangered on account of an insufficient supply of skilled mechanics. Whom can we call to account for this state of affairs? I feel inclined to find the cause of this industrial predicament largely in the attitude of the manufacturers themselves.

The leaders of industries (managers and engineers) have not been sufficiently interested in this important matter; and they have not joined forces with educators in giving to the youth the very equipment which the industries demand of him. The burden has been upon the schoolmaster, who, largely confined within the four

*Presented at the New York meeting (December, 1906) of the American Society of Mechanical Engineers.

walls of the school room, has worked out his problems with pedagogical exactitude, according as he perceives the life needs of the boy; but not being himself engaged in practical industrial work, he has not been conscious of the rapidly changing forces that determine the character of industrial life. The manufacturer, in the midst of the bustle of business activity, on the other hand, is confronted day by day with the inadequacy of preparation for practical work of the great body of industrial recruits. He knows the peculiar requirements and therefore should take the initiative to a large extent in coöperating with the schoolmaster in his efforts to provide an adequate industrial training.

Manufacturers in general do not realize their present responsibility. Years ago, before vocational training entered into the school system, they applied themselves to the task of initiating boys into the trades; and the results achieved through their efforts seemed to meet the conditions of that time.

THE OLD SYSTEM ALL RIGHT IN ITS DAY

The old system of apprenticeship, once universally extant, solved the problem well. A boy was apprenticed to a journeyman who taught him a particular trade until the boy became sufficiently skilled to take and hold his place by the side of his master, who himself was an all-round artisan. The artisan of all-round skill, however, has been gradually supplanted by the specialist, skilled in one particular operation only, and consequently the old system of apprenticeship has practically become extinct. Under the methods of specialization, manufacturers employed larger numbers of semi-skilled and unskilled workers, and became less alert to the necessity of manning the complicated specializing machinery which came into use with men of higher skill, and of marshaling the large army of specialists with men of a more thorough all-round training and a higher industrial intelligence. This lack of foresight, however, soon showed its effect on the personnel of the working body, and called attention to the immediate necessity of providing a means for the constant renewal of the supply of skilled workers. Manufacturers found themselves confronted with the serious problem of reconciling the discrepancy between the educational equipment which the boy receives in the school, and the vocational equipment which the industries demand of him.

They became thoroughly aroused to the importance of this question, and looking back to the old apprenticeship system, began to revive it along changed lines to suit the new industrial conditions. Much progress has been made in this respect in the last few years, even to the extent of combining with the practical shop work theoretical education given in the factory for the purpose of producing an artisan of superior make up.

A MODERN EXAMPLE

A significant example of this modern training by manufacturers is to be found at the Lynn works of the General Electric Company. The undoubted success of this apprenticeship system and the novel features which it contains justify a brief outline. This system offers to boys with a grammar-school education, who are at least 16 years old, an opportunity to learn a trade. Great care is exercised in selecting applicants and a further weeding-out process takes place during the trial period of about a month or two—the initiation period of every apprentice. Those boys only who during the trial period give proof of native ability for the trade which they wish to learn, and who are of the general mental and normal make-up that will insure the probability of their becoming skilled artisans, as well as assistant foremen and foremen at some future time, are allowed to sign the regular apprenticeship agreement.

WAGES

The latter provides for a service of four years at stipulated wages along a progressive scale, which is set with a view of making the boys self-supporting from the beginning—even during the trial period of service. In round figures, the compensation is $4.50 per week during the trial period and the first six months; $5.60 per week during the second six months; $6.70 per week during the second year; $7.80 per week during the third year, and $9.25 per week during the fourth and last year. A cash bonus of $100 is paid at the termination of the course, and a "Certificate of Apprenticeship" is given to the boy at that time.

TRAINING LEADERS

It is the aim of the General Electric Company to train skilled artisans in the various trades of machinist and toolmaker, carpenter and patternmaker, iron, steel and brass molder, instrument maker and electrical worker, in such a thorough manner that the leading positions in the factory, such as assistant foremen, foremen, master mechanics, and superintendents may be filled from the ranks of graduated apprentices.

It is obvious that such leaders must possess some information besides the practical knowledge of the trade—an industrial intelligence, which has been admirably defined by the Massachusetts Commission on Industrial and Technical Education as: "Mental power to see beyond the task which occupies the hands for the moment to the operations which have preceded and to those which will follow it—power to take in the whole process, knowledge of material, ideas of cost, ideas of organization, business sense, and a conscience which recognizes obligation."

In order to gain this result, the General Electric Company has correlated with its purely trade instruction at the machine a theoretical training of an eminently practical character, designed to supplement and amplify the former, so that the boy may be able to apply in the workshop the knowledge which he gains in the school room.

CLASS ROOM

Every apprentice receives instruction in the class room for six hours a week during ten months of the year, no school instruction being given during July and August. This enables the boys to take a week's vacation in the summer without conflicting with their school work. The school rooms are close to the workshop, and the sessions are held during working hours, arranged in such a way that about one-fifth of the apprentices are at school at one time. The boys are paid the same wages during school hours that they would receive while working at the bench or at the machine. The object of this is to make them feel the importance of an education; some of the boys might otherwise be unwilling to obtain an education at the sacrifice of wages.

After all, we must not forget that these apprentices are only young boys of limited breadth of view, some of whom perhaps have left school because it has become drudgery, others because of the necessity, due to unfortunate circumstances, to earn a living, and still others on account of a craving desire for money making. We must be lenient with this latter class who would prefer the hours in the shop with immediate returns in money to the hours in school with a remote promise of larger returns.

The desire for education is latent in every boy, to a smaller or larger degree, and needs only some stimulus to bring it to the surface. The payment of a compensation during school hours offers this stimulus. The company in the long run gains by this expenditure in that it develops for itself more efficient workmen.

THE TEACHERS

The teachers in the school room are men selected from the staff of engineers, draftsmen, and foremen of the General Electric Company, who are assigned for six hours a week to the work of teaching. These teachers are chosen not only for their good standing in their own profession, but also for the pedagogical qualifications which they may possess. It is obvious that these men are better acquainted with the needs of the factory, and of the industries in general, and can impart more practical instruction than educators far superior in pedagogical attainments, who have not had the advantage of the close touch with industrial activities.

The teachers meet fortnightly at faculty meetings to discuss the work of the school and the individualities of the pupils, for the purpose of maintaining a correlated system throughout the class rooms, and at the same time deciding upon the individual teaching that each boy requires.

The subjects which comprise the course

of studies are: Mathematics, physics, technology, and mechanical drawing. For the purpose of this paper it may not be necessary to go into the details of the interesting school program which has been described fully in articles previously written by the author of this address. It may suffice to call attention to two points, which will at once appeal to the manufacturer for their practicability.

TEACHING APPLIED DIRECTLY TO THE SHOP WORK

The teaching is preëminently concrete, and applicable to factory conditions. The young mind can more readily grasp problems of a concrete nature. By selecting them from the actual occurrences in the factory, there is the double advantage of initiating the apprentices into the technicalities of the business, making them acquainted with the different kinds of apparatus manufactured and the different materials used; and of familiarizing them with the solution of the very problems which they will meet later on as journeymen and foremen. The figuring out of the cubical contents of a cylinder of given diameter and length is a purely mathematical problem of mental discipline in which chiefly the memory is called into play; it becomes, however, an interesting problem which demands also the exercise of the thinking faculty if it is stated in the following manner:

"An order calls for 25 steel pins each to be ½ inch in diameter and 2 inches in length. The pins are to be cut from a rod of cold-rolled steel, and the tool used in the cutting-off machine will waste 1/32 inch of material between each two pins. How many pounds of cold-rolled steel are required to fill the order?"

This is a problem which is met with in everyday factory work, and involves nothing but plain multiplication and addition in its solution.

Study thus becomes a thing of life importance to the boy; and the teacher keeps this interest awake by presenting, wherever possible, the objects of which he speaks, and explaining their character and usefulness.

DRAFTING TAUGHT AS PART OF SPECIAL TOOL DESIGNING

The second point worthy of note is the part which mechanical drafting plays in the program. This is taught, not for the purpose of developing mechanical draftsmen, but as a means of teaching the designing of tools, jigs, and fixtures needed for manufacture on a large scale. The public-school system does not, and for that matter cannot, teach tool designing; and even the higher institutions of technical learning do not give due consideration to this subject, which is a very important requisite for the future mechanical engineer and shop superintendent. These, as well as the skilled mechanic, ought to possess the ability to sketch out the special tools, jigs, and fixtures that may be required from time to time for labor-saving manufacture. It is not so much a question of executing fine drawings that may be used over and over again, as in the case of the manufacture of a standard article, as it is a question of sketching quickly, for the immediate use of the machinist and tool-maker, a required tool which when once made is expected to remain in use for a long period. Mechanics who possess this ability of combining the work of the tool-maker with the work of the tool designer have added considerably to their assets, and have, therefore, become more valuable to their employer.

The General Electric apprentice is being educated along these lines, for which reason a large amount of the time set aside for instruction in the school rooms is devoted to the teaching of tool design in the upper classes. At this stage of the course, the apprentice has had several years of practical work in the shop, and therefore understands what is wanted of him and appreciates the value of designing jigs and fixtures with a view of saving every minute in the handling of them. The apprentices are given by the teachers a machine part, for instance, or a drawing of it, with the instruction to design a jig or holder, by means of which the various holes in the part may be drilled accurately and quickly without the necessity of laying out each hole separately and employing high skill for the operation. Each apprentice will present a different design which brings out his mechanical ingenuity, and this gives the drawing teacher a valuable help in developing the individuality of his pupils.

Examinations on the school work are held frequently during the year, and a final examination at the end of the course determines, to a certain extent, the standing of the apprentice, and the wages which the company considers commensurate with his value as a journeyman.

DEGREE OF SKILL ACQUIRED

The other element in this consideration is the degree of skill acquired by the apprentice through his shop training. The methods of training employed are of paramount importance in developing this skill, and it is this feature in the General Electric system which is of peculiar interest. Its adoption was the outcome of a study of the prevalent weaknesses of the present systems of apprenticeship. In most of these, boys are hired by the employment department and indentured for a number of years. They are assigned to one of the shop foremen who is instructed to initiate the young recruit into the trade which he desires to learn.

The foreman utilizes the apprentice at first for an errand boy, and for similar duties, giving him after a time simple work at the bench, such as chiseling, and plain filing in a machine shop, shellacking and sandpapering patterns in a pattern shop, making simple cores and cleaning small castings in a foundry; or letting him assist the stockkeeper in the handling of the small tools and the stock materials. There is a certain amount of value in all this work, in that it makes the boy familiar with factory life, accustoms him to the factory atmosphere, and gives him some elementary knowledge of his trade; but after a time the knee in the curve of value is reached, and a further expenditure of time gradually becomes more and more disproportionate to the additional advantage gained. The bright and ambitious apprentice realizes when the knee in the curve is reached, and begins then to press the foreman for higher-grade work, especially work at the machine. And so the apprentice step by step has to push himself forward in order to learn the different classes of work, and become acquainted with the operations on the different machines in the department. In general, the foreman is apt to be slow to give the boy the advantage of a variety of training; for if the boy is inefficient at some particular work, he will naturally be held at that work for improvement, and if he is efficient, the foreman is prone to keep the apprentice at the work for an undue length of time, in order to get the greatest commercial advantage from the boy.

Here lies the conflict between the purpose of the apprentice and the foreman. The boy comes for a training; he wants to secure all possible information in the shortest time, and therefore desires a variety of work in the department, and an opportunity to work in all departments of the factory. The foreman, on the other hand, representing the company, strives for economy, for cheapness of production, and he can better further his ends by keeping the apprentice at one class of work, and in one department for a long time. Few foremen combine with this legitimate care for their own interests the proper appreciation of the boy's object. Of course, we must acknowledge that there is a certain advantage in obliging the boy to forge ahead for himself against the difficulties which have been enumerated; for in this way the weak and undeserving will fall by the wayside and the fittest only will survive. Over against this, however, we must admit that many apprentices who succumb to this unequal struggle would under more advantageous conditions come out victorious.

Realizing this, some manufacturers have employed a suitable man to look after the apprentices during the whole time of their course and to assist the foremen in giving the boys an adequate industrial training. This overseer, as we may call him, jointly represents the interests of the employer and the apprentices; and to the extent to which he possesses breadth of view he will fulfil this dual function to the advantage of both. In many instances his interest in the boys will lead him to inaugurate evening classes for the study

of mechanical drawing, mechanics, and kindred subjects, and even, perhaps, to influence them in their leisure hours.

A system of apprenticeship along these lines is a decided step forward in the right direction, but it still contains one important defect in common with the system first outlined.

In either case the apprentice is the pupil of whomever happens to be foreman, assistant foreman, or leading journeyman in the department to which he has been assigned. These men have been selected for their skill, and not on account of any special fitness that they may have for instructing boys. It is well known that few people in whatever walk of life, with the exception of professional teachers, are qualified to impart information in a satisfactory manner, though they may themselves possess this knowledge and may well be able to apply it to their work.

The drawback under which the boy thus labors is often further intensified by the productive requirements in commercial manufacturing establishments. Some departments, for instance, may have only a small amount of work on hand and of such a nature that it will not add to the boy's skill and knowledge; while others may be crowded with work of an instructive and interesting character. The boy who happens to be assigned to the first department is, therefore, put at a decided disadvantage over the apprentice in the other department where productive conditions offer a splendid opportunity for his further advancement. The realization of these weaknesses in the systems of apprenticeship leads to the remedy that should be applied, which is to equalize the opportunities of all apprentices, and to afford them the most expert instruction in the practical work of the trade, especially during the first part of their course, for a solid or faulty foundation determines the strength or weakness of the whole structure of achievement. The General Electric Company has proved the validity of this remedy.

THE APPRENTICES' SHOP

Four years ago it started as a special department devoted entirely to the preliminary, practical training of the apprentices a small shop in the big factory organization, directly under the control of the man in charge of apprentices. Beginning in a small way, this "Apprentice Training Room" has grown in size and equipment until today it covers an area of about 10,000 square feet with a tool equipment of 105 representative machines. There are 20 drill presses of various sizes, 4 speed lathes, 1 pulley lathe, 1 turret lathe, and 44 engine lathes, some of which are belt driven, while most of them have individual motor drives. These engines lathes vary in sizes from 12-inch swing and 5-foot bed to 20-inch swing and 8-foot bed, and are fitted up partly with plain rest or rise and fall carriage or compound rest and partly with taper attachment suitable for tool work. There are also two 24-inch planers, nine 15-inch shapers, one 42-inch vertical boring mill, two plain and two universal horizontal milling machines, one vertical milling machine, one centering machine, one spliner, one wet grinder, two universal grinders, one surface grinder, four tool grinders, one hack saw, two arbor presses, one bench watchmaker's lathe, besides a number of small electric bench drills, buffing and polishing motors. Then there are, of course, the necessary small tools, such as drills, taps, reamers, chucks, and arbors, besides 40 vises.

Most of the machines are of the latest and most improved type, while some of them are second-hand tools, a few of which have even been rescued from the scrap heap. There is a twofold purpose in the use of old machines—the economic and the educational; it prevents the abuse and injury of high-priced modern machinery, which is apt to occur with boys who have not had experience in the handling of machines, and it affords an opportunity for repairing machine tools, which is undoubtedly the best training that can be given to a future mechanic, since it develops the ability to do things, thoughtfulness, and self-reliance. Some of the old lathes have thus been provided with new gears, the spindles have been turned down, the bearings rebabbitted, or some special attachments have been added until they have been made practically as useful as some of the expensive modern lathes. A stockroom of suitable size occupies one corner of the training room and is conducted in the same manner as a stockroom in any well managed manufacturing establishment. This equipment is large enough to instruct about 125 boys at one time. Usually about 15 of these are applicants serving their trial period, while the rest are regularly indentured apprentices on their first and second year of service.

THE MAN IN CHARGE

The man who has charge of this training room is an ingenious mechanician, who has himself served an apprenticeship, has had charge of men and work, possesses the ability and patience to instruct beginners, and is peculiarly adapted to this kind of work. He interviews all applicants, and with a keen insight selects those who are to be admitted to the trial service. This gives him an opportunity to study carefully the boy's mental and moral make-up and his native ability for the chosen trade. A painstaking and encouraging attitude toward one, a severe and almost threatening arraignment of the other will bring out very often latent qualities that might not come to the surface except for this individual treatment. The careful selection of those who are to be admitted to full apprenticeship is a very important function of the shop instructor, in that it determines the personnel of the apprenticeship system. Under the stipulations of the contract, the General Electric Company has a right to terminate the service of any apprentice at any time for good cause, such as improper behavior or inefficiency of work; yet in accepting the boy for regular apprenticeship and indenturing him, the company has assumed a moral obligation for the development of the apprentice which it cannot very often cancel without forfeiting the faith and confidence of the public.

The instructor initiates the apprentices into the trade and lays the foundation for their future skill and efficiency. It is his duty, wherever possible, to inaugurate with the apprentices labor-saving methods of manufacture, and to make and use labor-saving devices which thereafter will be accepted by the other factory departments. He can without difficulty develop the highest practical cutting speeds and thus set a standard in this respect to the whole factory organization. The training room stands for the best and most efficient methods, and is not hampered in its development along these lines by a hostile attitude which may be encountered in factory departments on the part of regular workmen, which is usually due to ignorance or misunderstanding of the true conditions. The shop instructor has two assistants, this small number being made possible by carrying out the policy of utilizing most of the apprentices themselves for assistant instructors. After an apprentice has learned thoroughly a certain operation, turning of pulleys, for instance, he is usually required to break in a new apprentice on this kind of work before he himself is taught another operation, boring, for example, by an older apprentice who has already learned this operation.

In this manner, the apprentice is pupil today and teacher tomorrow, then pupil again and teacher once more. The advantage of this policy is obvious. It develops early in the apprentice the faculty to instruct, and keeps him wide-awake in his work. The young master will put forth his best efforts to impress the young recruit with his own achievements, and the latter will often not hesitate to ask his boy teacher questions that he may not, out of false pride, ask the regular instructor. Couples of boys may, therefore, be seen in the training room almost every day. A study of their instructive and receptive efforts is quite interesting. Some of the apprentices are required to spend a few weeks in the stockroom and learn stockroom methods, or act as clerks to the shop instructor in order to become acquainted with the clerical duties of a shop foreman; the making out of time cards and reports, the ordering of raw materials, and the shipping of finished goods. The object of all this training is to make real workmen, and this can be achieved only by carrying on real work. All production

in the training room, therefore, is of a commercial value.

WHAT THE SHOP DOES

The General Electric training room makes cast-iron pulleys of various sizes and design, clutch pulleys and flange couplings, small and large parts of regularly manufactured machinery instructive in the teaching of turning and boring, drilling and grinding, planing and shaping, milling and slotting; it manufactures shafts for fan motors and power motors, and spindles for various purposes, and finally produces not only the special tools, jigs, and fixtures needed for its own use, but also many of those required for other factory departments. The psychological value of commercial work is of great importance; it takes the boy out of the sphere of laboratory work into that of industrial life; it clinches the boy's interest, inasmuch as it makes him realize that the product of his work is to be a part of some useful machine, rather than a plaything or an object of exhibition in some show-case. The possibilities of apprentices under proper instruction, having the right interest in their work, are remarkable. Almost every week brings new surprises in the General Electric training room at Lynn.

A training room similar to the one just described for machinist apprentices, is maintained for the patternmaker apprentices. This has a less complete equipment of its kind, however, on account of the smaller number of boys indentured for this trade. This condition may be improved at some future time by enlarging the machinist training room through the addition of a suitable pattern-shop equipment.

The General Electric Company has only a few foundry apprentices who are instructed in the regular foundry. It stands to reason, however, that a sufficiently large number of foundry apprentices would justify the installation of a foundry training room.

A separate building with foundry, patternmaker, and machinist training rooms, with the class rooms on the top floor, would be the ideal trade school in the factory.

After the apprentices have spent from 1½ to 2½ years in the training room, according to their individual ability, they are transferred to factory departments, where they serve a post-graduate course for the remaining part of their apprenticeship. They learn here accuracy and speed on a greater variety of work, and have an opportunity to specialize in die-making or tool-making, or laying out machine work for which they are best suited. The apprentices are now under the charge and discipline of the respective shop foremen and have to all intents and purposes taken their places beside their shop mates, although they still attend the apprentice school. The shop instructor, however, retains his interest in the apprentice whom he may transfer from one department to another, either at the request of the foreman or the apprentice, or whom he may even take back temporarily to the training room, either for the good of the service or for the rectification of some defect that the boy may have developed in his work. If a disagreement between a foreman and an apprentice arises, the shop instructor acts as a mediator. He considers the apprentices as his boys and looks upon them in that light even after they have become journeymen. He passes final judgment on the apprentice when he determines the standing to be recorded in his "Certificate of Apprenticeship."

RETAINING GRADUATES

The General Electric Company encourages all graduated apprentices to remain in its service and, as previously stated, hopes that in due time most of the assistant foremen and foremen in the factory will be graduated apprentices. Some of those who have shown a special ability in their drawing work in the class room are appointed as tool designers in the drawing office, where their combined knowledge of tool making and practical tool designing puts them far ahead, in this line of work, of even college educated but not shop trained draftsmen.

Up to this date 462 boys have been admitted to the trial service, and 293 of these have been indentured as apprentices. Of the latter 37 have terminated their contract with the consent of the company on account of sickness, removal of the family from town, or other good reasons; 35 have broken their contract by seeking other employment during their apprenticeship, and 21 have been discharged for good reason. Of the remainder, 29 have graduated; 171 are still on the apprenticeship course, and 37 are serving their trial period. Of the graduates 24 are still in the employment of the General Electric Company at Lynn, and most of those who have sought other employment will sooner or later return to their *alma mater*.

Very often the graduated apprentice with the hundred dollars cash in his pocket determines to seek employment in some other place in order "to see something of the world," as he puts it. Such desires should not altogether be discouraged; it will often do a boy a great deal of good to get among strangers, and the rubbing up against the world will take off the rough corners, and round him out into a fuller and better man.

The success of the General Electric plan is not peculiar to the conditions which exist there; it can be applied in a more or less modified form to any manufacturing concern of suitable size. Its establishment should be encouraged, since it benefits alike the apprentice who obtains an excellent industrial training and the employer who not only develops efficient men for himself, but does it at no financial sacrifice, on account of useful work performed in the training room. The picture of a well-equipped training room suggests another thought in carrying out the plan to provide for a constant supply of skilled workmen. It has often been pointed out that our public-school buildings with their expensive equipment ought to be used for more than six hours a day, five days in the week and forty weeks in the year. This contention has led to the social utilization of the schools for evening classes, public lectures, parents' associations and neighborhood clubs. May we not begin to point to the uneconomic condition under which large factory buildings with their costly equipment are left idle from 6 at night until 7 in the morning, and in many cases from noon on Saturdays? Cannot these factories be utilized during these idle hours for industrial extension work for the benefit of the people without expense to the employer? The training room affords an excellent opportunity for a beginning. It is a self-contained department with a full equipment necessary to learn the machinist's trade in all its principal branches; and, as a rule, work left in the machine at the close of the regular factory hours is not of as expensive character as may be found in ordinary machine shops, where the removal of it from the machine may seriously interfere with economic and quick production.

EVENING CLASSES

This training room could, therefore, be opened from 7 to 10 at night, and on Saturday afternoons, to those employees of the company who desire to learn the machinist's trade or some part of it. There are undoubtedly many ambitious workingmen, who on account of lack of education and skill or through thoughtlessness in their younger days are now occupied with unskilled labor with no apparent chance of rising either in position or in wages. They may be anxious to improve their condition by learning to do work on a lathe, planer, shaper or boring mill, or on several of these machines. What opportunities have such men now for gratifying their ambition? Some, through perseverance, may persuade their foremen to put them at one of these machines where they would receive more or less superficial instruction. They have there a chance to earn somewhat increased wages, especially if they become experts on one machine. Further advancement is probably precluded.

Some workmen are fortunate enough to live in one of the few cities in which evening trade schools have been established. But what about the great majority of unskilled workers who could acquire some skill, and thus rise from a lower to a higher industrial efficiency, if they had an opportunity to be instructed in practical work during their leisure hours? Let these men in the factory come together in

small classes for learning to do such work as their ambition dictates, and utilize the training room for three evenings a week. The shop instructor of the apprentices with able assistants may well take charge of this evening training for which he, of course, would receive extra compensation. The instruction should be thorough in regard to the work on the machine as well as the machine itself, and those only who satisfy the shop instructor of their ability should be allowed to remain. Fairly good lathe, shaper, planer, or boring-mill hands can be turned out after six to nine months of evening instruction, and universal milling machine operators in about a year's time. Those who satisfactorily complete a special course should be given a certificate of special apprenticeship, and for each subsequent additional course completed an additional certificate should be issued.

The work in the evening classes should consist of regular factory work, and the value of properly finished pieces to the company would probably offset the expense of heat, light and power, wear and tear of machinery and small tools, and spoiled material. A small tuition fee of perhaps three dollars a month would pay for the salary of the instructor and his assistants.

This is only a brief outline of a plan which can be worked out as an excellent investment for the workman who thus increases his earning capacity, and for the employer who adds to his supply of skilled workers. One can readily perceive how many a workman, through close application to several years of practical evening instruction, may develop into a skilled mechanic even though he has not had the advantage of an apprenticeship training. The possibilities of the one are as great as those of the other.

We have so far considered ways and means by which an employer may provide for a constant supply of skilled workmen for his own benefit. What can be done by the individual for himself can undoubtedly be accomplished for the industries in general by the right man and the right methods. It would necessitate the separation of the training room from the individual factory, and its establishment as an independent institution in a place where its work could be of benefit to the industries of the locality. The day course would have to be elaborated upon in order to include what has been previously termed the "post-graduate course in the factory," so that the apprentices may go from here directly into the industries as full-fledged journeymen. There are advantages and disadvantages in the independent school shop as contrasted with the factory training room.

The school shop will be able to attract a desirable class of boys who would gladly enlist in an institution of a vocational character, but would not care to enter upon an apprenticeship course in a factory. The lack of respect for mechanical work on the part of the American youth is responsible for this state of affairs. There is the other marked advantage of having an institution that is centered on one interest—the training of efficient workmen. On the other hand, the school shop has not the amount and variety of work right at hand which obviously the factory training room can command at all times. Able business management, however, will overcome this difficulty so much the more readily as manufacturers have a selfish object in furthering the aims of the school shop; the latter must also provide for the design and manufacture of an easily salable article that can, therefore, be produced for stock at such time when other commercial work cannot be obtained in sufficient quantity.

The standard of the school shop must be of the highest, so that it may commend itself through the excellency of its graduates, both in the day and evening classes, to employers, employees, and the public in general. A high standard must be maintained in the practical shop training as well as in the purely educational work. The latter may be conducted along the lines worked out by the General Electric Company, or it may be placed under the charge of the public-school authorities, who, after all, are responsible for giving the boys the training which they need to make them self-supporting members of the community. The State would also infuse a sufficient amount of the cultural element to develop the boy at the same time into a man and a law-abiding citizen. This latter plan, however, could only be carried out if the school authorities of the town in which the school shop is located would consent to the establishment of a special school course, offered at such times of the day when a part of the apprentices could be spared from the school shop. The special school program would have to be worked out so as to meet the demands of the industries and would have to be taught by properly qualified teachers whom we might term, "industrial instructors." Until such conditions prevail, the school shop will have to look after its own educational work. Proper conditions may be brought about quickly in Massachusetts, for instance, through the coöperation of the management of the school shop and the Massachusetts Commission on Industrial and Technical Education. The commission was appointed recently for the purpose of studying the industrial needs of the State and of establishing industrial courses and trade schools that will answer these needs. The school shop could serve the commission as a laboratory, in which they could work out jointly with the manager of the same an adequate industrial training of the boys.

Under this combination the school shop may be run as a commercial, profit-making establishment without any injury to the educational development of the apprentices but with some advantages which an educational institution of even a vocational character cannot offer.

In this address I hope I have stimulated interest among the manufacturers in the subject of providing for a constant supply of skilled workmen, and trust I have indicated a possible plan that will readily lend itself to the solution of the problem under existing conditions.

A Locomotive with a Water-tube Boiler

The water-tube steam boiler has attained a large degree of popularity in stationary, marine and automobile service, but it does not as yet appear to have been able to displace the tubular or flue boiler in locomotive service. Every once in a while somebody gets up a design of a water-tube boiler for this purpose, and one of the latest of these was shown in a locomotive at the Milan Exposition. The upper portion of this boiler is a drum which carries water a little above its center line; entering its lower side are numerous curved tubes communicating with a "mud-drum" below, which, however, does not extend all the way back, the space underneath the rear portion of the steam-drum being occupied by the fire-box, the sides of which are formed by some of the curved tubes which run down from the steam-drum to a box at the level of the grate. The back of the fire-box is formed of fire-brick and the front is also fitted with fire-brick which extends back and forms the usual brick arch. The gases pass forward around the curved tubes between the upper and lower drums to the smoke-box, and the soot deposited by them on the tubes is removed by jets of steam from pipes provided for that purpose. The steam-drum is equipped with the usual dome. The total heating surface of the locomotive shown is 1165.5 square feet.

Increase of Wages at the Yale & Towne Plant

Henry R. Towne, president of the Yale & Towne Manufacturing Company, Stamford, Conn., at a meeting of its superintendents and foremen, held recently, made announcement of an increase of wages and piece rates which will probably involve an addition to its annual payroll of upward of $75,000, additional to increases recently made which aggregate more than $45,000, thus forming a total increase of $120,000 per year.

A feature of the closing year is that there is a general tendency toward increased wages of workers in industrial establishments and in view of the greatly increased cost of living, most wage earners will be of the opinion that the rise in wages has come none too soon.

A NOTEWORTHY EXAMPLE OF MODERN ILLUMINATING ENGINEERING*

An Object-lesson in the Lighting of Shops and Drafting Rooms—The Number and Kinds of Lamps Employed, and the Amount of Electrical Energy Required

The artificial lighting of the engineering laboratories recently dedicated at the University of Pennsylvania affords an excellent example of the results obtained in that growing branch of the electrical art—illuminating engineering. Every room in this modern structure has been the subject of careful study from the lighting standpoint and as a result the new laboratory is probably the best lighted in the world.

Both arc and incandescent lamps have been combined to produce this result; arc lamps of the inclosed type with concentric diffusers being used for illuminating the larger areas, while the G.E.M. high-efficiency lamps with Holophane Pagoda shades, and ordinary incandescent lamps, used singly and in clusters, have been adopted for lighting hallways, lecture rooms, etc. The lighting equipment was installed by the General Electric Company.

The new building (which was described in the AMERICAN MACHINIST, at pages 525 and 593), with basement and three stories of rooms having various lighting requirements, presented a nice problem for the illuminating engineer, and the installation because of this varied character is typical of modern lighting practice. Within the building are machine shops, drawing rooms, laboratories, offices, lecture rooms and library, each group exacting certain lighting values.

THE ILLUMINATION IN THE SHOPS AND LABORATORIES

The basement, containing rooms for storage, lockers, etc., is lighted by ordinary incandescent lamps and requires no special mention. On the first floor, however, the illuminating plans are noteworthy. Here are located the principal mechanical and electrical laboratories and the shops, as well as various small laboratories and offices. The mechanical laboratory, with heavy machinery and wide open spaces, requires a general, brilliant illumination with the light so diffused as to prevent shadows behind machines. For this purpose inclosed arc lamps have been installed of the type made by the General Electric Company, equipped with concentric diffusers. The diffuser consists of a circular sheet-iron reflector, in the form of a broad inverted cone, the white enameled surface being corrugated in concentric circles, designed so as to distribute the light from the arc below to best illuminate the floor beneath.

In the wood-working, iron-working and forge shops, and in the dynamo, testing and hydraulic laboratories, on the first

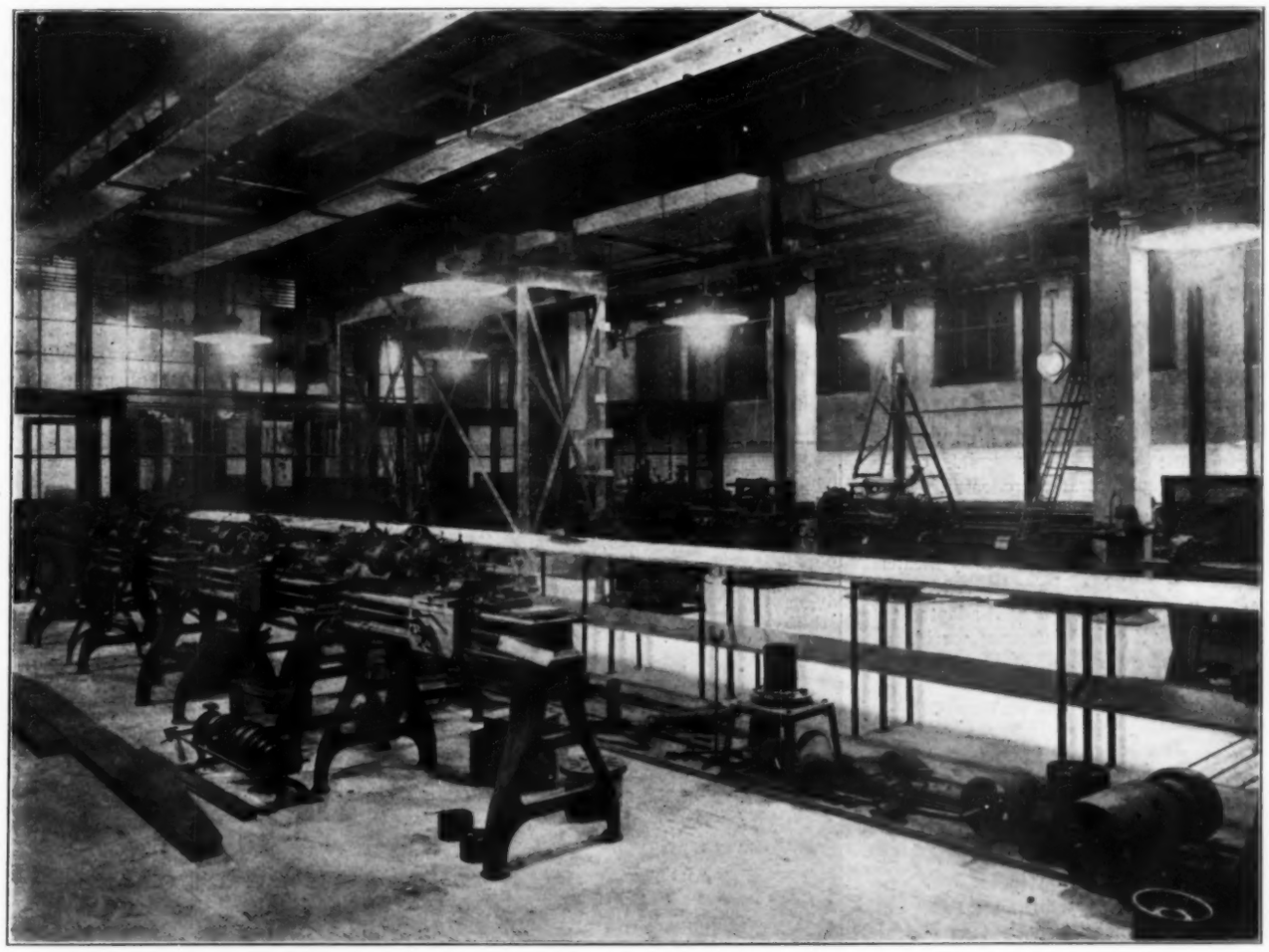


FIG. I. REPRODUCTION OF A NIGHT PHOTOGRAPH OF MACHINE SHOP, TAKEN BY THE ELECTRIC LIGHTS, SHOWING EXCELLENT DISTRIBUTION OF LIGHT

*The development of the science and art of illuminating has been of late years attaining to much importance, and since the providing of sufficient and proper light is such a strong commercial and hygienic factor in the conduct of industrial enterprises, it will be useful to have readily available the data relating to an installation of such efficiency as that herein described.—Ed.

floor, conditions prevail similar to those obtaining in the mechanical laboratories. Arc lamps with concentric diffusers are therefore used, arranged as indicated in Fig. 2. The excellence of this illumination can be seen in Fig. 1, which is reproduced from the original photograph taken by the light of the lamps. The absence of shadows, and the even distribution of the light are particularly marked. Scattered incandescent lamps are available for lighting parts of machines and work.

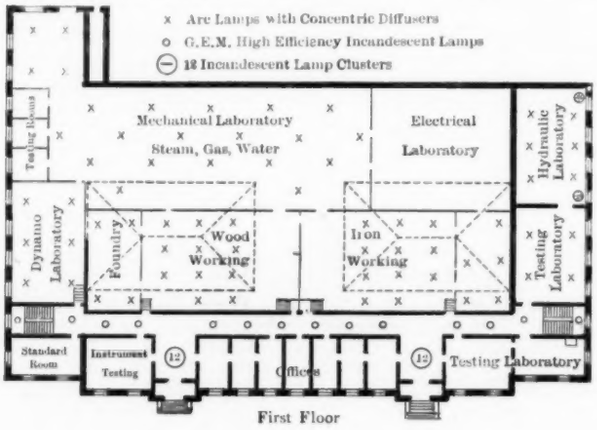


FIG. 2

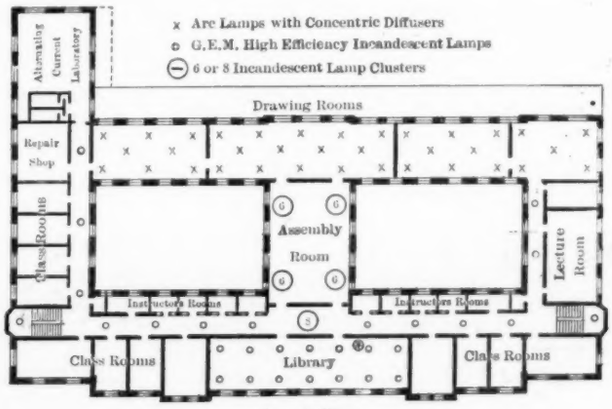


FIG. 3

PLANS SHOWING LOCATION OF LIGHTS

THE HALLWAYS LIGHTED BY INCANDESCENT LAMPS WITH HOLOPHANE GLOBES

The hallways form another problem in lighting, which in this instance has been interestingly worked out by the use of high-efficiency incandescent units combined with a concentrating reflector. The units are of the No. 4 G.E.M. type utilizing 187 watts and concentrate 180 candlepower in a downward direction by means of No. 5 Holophane Pagoda reflectors. This method of lighting is well adapted to the long, comparatively narrow corridors, and the excellent results so obtained are indicated in Fig. 4.

DIFFUSED ILLUMINATION BY ARC LAMPS IN THE DRAFTING ROOMS

In Fig. 3 is shown the lighting plan of the second floor. On this and the third floor the drafting rooms present the most interesting feature. From the nature of the case, the illumination in these rooms must be the best, pure, brilliant and well diffused, so that work can be done accurately by artificial light. The inclosed arc lamp with concentric diffuser has been selected for this purpose with the result shown in Fig. 5. This illustration is also taken from a night photograph, and the sharpness of the illumination obtained, combined with the evenness of the distribution, is striking.

THE LIGHTING OF OTHER LARGE ROOMS

Aside from the drawing rooms, the rooms on the second and third floors incorporate other instructive features in illuminating engineering. The assembly room on the second floor is lighted by diffused and restful, quite in keeping with the purpose of the room.

On the third floor are the museums and auditorium, both lighted by incandescent lamps arranged in clusters. General illumination is, of course, the chief requisite here. The hallway on this floor is lighted by G.E.M. units.

TABLE OF THE LAMPS AND AMOUNT OF ELECTRICAL ENERGY PROVIDED IN EACH CASE

In order to make the comparison of illuminating value more convenient, the following tables have been prepared showing the character and dimensions of the room, the unit of illumination, and the watts per square feet. It will be seen that the drawing rooms require the greatest amount of light, averaging 2.65 watts per square foot, while the shops come next, with an average of 1.8 watts per square foot of floor area. With these figures as a basis it would be quite possible to figure the amount of current necessary to light any building satisfactorily to meet different conditions, providing the floor area were known.

The multiple-voltage system of electric drive has been found of great advantage in the cloth-printing industry.

FIG. 5. DRAFTING ROOM ILLUMINATED BY ARC LAMPS

Besides the great economy over the use of direct-connected steam engines, it gives an exceedingly convenient regulation of the speed of the printing machine, so that a low speed may be used in "making ready" and after all is fixed the speed best suited to the particular conditions of the job can be readily obtained.

The Lubrication of Air-compressor Cylinders

"Air Compressor Lubrication" is the title of a 22-page pamphlet published by the Joseph Dixon Crucible Company, Jersey City, N. J., which, though being really an advertisement of Dixon's flake graphite as a lubricant contains so much useful and interesting information as to merit the designation of essay. Lubrication of air cylinders with oil is first discussed and the following among others are some of the disadvantages which it is stated appertain to this mode of lubrication; the tendency of oil to "carbonize" or to form deposits in the discharge pipes; the tendency of old deposits of oil to collect dust, etc., choking the passages; the clogging and leakage of discharge valves resulting in the recompression of air already hot and the development of dangerously high temperatures; the vaporization of oil and the formation of explosive mixtures of such vapors with the air in discharge pipes and receivers. Methods are discussed and devices shown for feeding graphite into the cylinder either with oil or with soapsuds. Another disadvantage of the use of oil in the air cylinder is the carrying of oil fumes by the air so that rubber hose is caused to deteriorate, water rendered disagreeable, etc.

Room.	Unit of Illumination.	Dimensions of Room.	Watts per Square Foot.
	FIRST FLOOR		
Mechanical laboratory	22 arc lamps with concentric diffusers	Main 162 x 63 ft. Bay 37 x 39 ft.	1.0
Electrical laboratory	2 high-efficiency 187-watt G. E. M. units. 94 16-c.p. incandescent lamps	72 x 63 ft.	1.22
Dynamo laboratory	6 arc lamps with concentric diffusers. 18 16-c.p. incandescent lamps	62 x 38 ft.	1.82
Work shops	52 arc lamps with concentric diffusers. 42 16-c.p. incandescent lamps	213 x 51 ft.	1.84
Hydraulic laboratory	6 arc lamps with concentric diffusers. 13 16-c.p. incandescent lamps	63 x 38 ft.	1.68
Testing laboratory	14 arc lamps with concentric diffusers. 11 16-c.p. incandescent lamps	46 x 38 ft.	1.6
Testing laboratory offices, standard room, etc	84 16-c.p. incandescent lamps	6300 sq. ft.	0.72
Corridors	14 high-efficiency 187-watt G. E. M. units. 24 16-c.p. incandescent lamps	3741 sq. ft.	1.05
	SECOND FLOOR		
Drawing room	18 arc lamps with concentric diffusers	58 x 31 ft.	2.45
	14 arc lamps with concentric diffusers	93 x 31 ft.	2.68
	8 arc lamps with concentric diffusers	58 x 31 ft.	2.45
	6 arc lamps with concentric diffusers	46 x 31 ft.	1.92
Library	14 high-efficiency 187-watt G. E. M. units.	98 x 28 ft.	1.0
Assembly room	24 16-c.p. incandescent lamps	44 x 63 ft.	0.48
Corridors	12 high-efficiency 187-watt G. E. M. units. 8 16-c.p. incandescent lamps	11 x 300 ft.	0.81
	THIRD FLOOR		
Drawing room	14 arc lamps with concentric diffusers	87 x 38 ft.	2.33
	17 arc lamps with concentric diffusers	116 x 31 ft.	2.6
	13 arc lamps with concentric diffusers	80 x 31 ft.	2.88
	9 arc lamps with concentric diffusers	59 x 31 ft.	2.7
Museums	24 16-c.p. incandescent lamps	62 x 39 ft.	0.55
Auditorium	40 16-c.p. incandescent lamps	2772 sq. ft.	0.8
Corridors	10 high-efficiency 187-watt G. E. M. units. 8 16-c.p. incandescent lamps. Arc lamps 5 amps., 110 volts D. C.	11 x 300 ft.	0.7

TABLE SHOWING NUMBER AND KIND OF LAMPS, SIZE OF ROOM, AND CURRENT CONSUMPTION

FIG. 4. HALLWAY LIGHTED BY INCANDESCENT LAMPS WITH HOLOPHANE GLOBES

Materials Used in Motor-car Construction

BY E. J. BARTLETT, E. E.

No machine manufactured as a commercial product presents so many conditions to which its parts must conform as the automobile, particularly the gasolene type. To satisfactorily meet all the limitations and perform all the duties dependent upon it, a large variety of materials with different treatments must be used in the construction of its important parts.

Some of these materials are familiar, owing to their wide range of usefulness in machine construction, while others are comparatively new, having been produced and developed to meet the demands of the automobile industry. Doubtless these later materials will prove of value in other lines of work, as their characteristics and advantages become better known and appreciated.

A brief mention in an elementary way of the most important materials used for this class of work, together with the general reasons for their selection, may prove of interest to those not intimately acquainted with automobile manufacture.

Aside from the cost of production, which is necessarily an important factor in the construction of any machine, and one which is increasing in importance in automobile work as their manufacture increases, may be mentioned the size and weight as the limiting features to which the designer must concede. On the other hand, he has the problem of designing satisfactory working and wearing parts which are subjected to excessive and frequent vibration, sudden heavy shocks, high surface speed, heat and pressure. All these factors may be present either singly or collectively.

To facilitate our study of materials used to meet these conditions in typical American gasolene pleasure automobiles, let us divide them into a few groups based on their character or extent of use.

IRON CASTINGS

Cast iron does not enter into automobile construction to any great extent, yet the most of the small number of parts made of this material are important. Thus far no material has been found to equal a good grade of tough, hard, close-grained gray iron for motor cylinders, pistons, and piston rings. These parts must, to a more or less extent, be light yet strong; be close-grained enough to prevent leakage at the working temperature and pressure; be able to withstand the heavy and sudden stresses due to the explosive pressures; be soft enough to be practical to

manufacture, and must stand the intense heat on the inside, and the chilling effect of water or air on the outside without undue distortion or deterioration. The rings must not lose their elasticity and the intricate nature of the castings requires a material easily molded.

Besides the parts mentioned, cast iron is commonly used for exhaust manifolds, valve guides and seats, and similar small engine parts where the strains are light and the heat considerable. Fly-wheels, where the circumferential speed permits, are made of cast iron, as it is cheap. A few other parts, such as muffler heads, might also be added to the list.

MALLEABLE CASTINGS

Large castings taking heavy loads, such as engine bases, transmission-gear cases, and rear-axle housings, are frequently made of malleable iron, although some grades of aluminum and bronze are taking its place (except for axle housings) to quite an extent, owing to the weight and length of time necessary to procure castings. It is one of the most convenient of the cast metals, however, and is extensively used for miscellaneous small parts requiring strength and stiffness. It can also be cast in thin sections, which is often desirable for light parts. Further examples of its use are brake brackets, flanges, and spring chairs.

STEEL CASTINGS

For cast parts requiring the maximum strength and comparatively simple in section, cast steel is applicable. Such parts are spring hangers, torsion brackets, brake anchors, wheel hubs and driving sprockets. Like malleable iron it takes a long time to procure castings, and besides is not altogether satisfactory owing to numerous blow-holes and flaws in the castings which may not be found until the parts are machined or even in service. It is a material not extensively used where the strength required permits a more dependable cast metal or where the shape of the part, or quantity to be made, warrants the use of a drop forging.

ALUMINUM CASTINGS

Aluminum castings have been greatly improved in strength and closeness of grain to meet the demands of the automobile industry and where formerly used only for dust shields or similar devices requiring little strength its field of usefulness has been increased so the better grades are now commonly used for large and important parts, such as engine bases, transmission housings, steering-gear cases, etc. Its great advantage is, of course, its lightness. It may also be cast in thin and intricate sections. Its lightness makes it an admirable material for fans and clutch spiders and other rotating parts where inertia or momentum is to be avoided. A few automobile bodies are even made in large sections, though this application is somewhat experimental in nature.

BRASS, BRONZE AND OTHER ALLOYS

A large number of special grades of brass and bronze have been produced, in addition to those previously used, to fulfil the requirements of automobile construction. Just how many really different grades would be difficult to say as some manufacturers and foundries prefer to advertise these metals under some special name, although they differ little, if any, from other grades used elsewhere. In fact many small foundries get their materials from the same source of supply and modify the metal in casting just enough to make it special in name.

For general work requiring strength and toughness, aluminum and manganese bronze, with various modifications of names, are extensively used. Of these the latter is the more common. These metals are used for front axles, transmission gear cases, brake anchor brackets, and small parts requiring special strength and of such section as to make steel castings or drop forgings impractical. These metals are easily machined, but they are heavy and expensive.

The grades used for bearing purposes vary widely from a hard phosphor bronze to white brass which approaches babbitt in character, thus meeting all mechanical requirements for speed, pressure, and lubrication. Not infrequently a manufacturer decides on perhaps three grades to fulfil all conditions. These may be a hard phosphor bronze for bearings taking severe stresses where the shaft has little motion; a medium hard phosphor bronze for general use; and a grade of white brass for bearings requiring toughness and softness, as in sliding gear transmissions, that the hard chips from the gears may easily imbed themselves in the soft metal and not score the shafts.

BABBITT METALS

Next in order babbitt may be mentioned as a bearing material. This is also found in different grades adapting it to all classes of work, the selection of the grade to be used depending on the same general conditions as noted for brass and bronze. Bearings difficult of alinement are sometimes poured with the rotating member in place, though this is a somewhat expensive method of assembling.

A hard babbitt is also sometimes used for steering gears and control operating devices where the principle of a nut and screw of special thread and pitch is used to change a circular motion of a wheel or lever into a longitudinal motion operating various linkages through connecting rods or tubes. Such a "floating" nut device is very expensive to make from steel and is satisfactorly made from hard babbitt. It can also be easily renewed when worn out.

FORGINGS AND BAR STOCK

Steel, of various grades, either in the forged or bar-stock state, forms the material from which the majority of machined parts are made. A great improvement in American steels has been made in the past few years. Some of the high-carbon and alloy steels, when properly treated, possess a strength and endurance which was unknown a comparatively short time ago. Probably no one feature has contributed so much to the success of the automobile as this increased strength of material entering into its important parts.

Considering the principal steels used for this work in the ascending order of strength we have the ordinary machinery steel entering into many small parts such as bolts, nuts, pins and shafts made from bar stock. Forgings from this material are used for gears and miscellaneous parts requiring medium strength.

The higher carbon steels come next in order and are used extensively for all sorts of work requiring a little more dependable material than ordinary steel yet not warranting the use of the expensive alloy steels. Examples of its use are axles, driving shafts, and gears.

Nickel steel alloys require special treatments to produce the maximum strengths. It is expensive and somewhat difficult to forge or machine. These features limit its use to comparatively few parts requiring a greater strength than carbon steels afford. These parts may be the most important in the car, such as the crank shaft and transmission parts.

Another alloy, still more expensive to buy and work and possessing greater strength, is chrome nickel steel. This steel is used in only the high-grade and high-priced cars for the few parts subjected to the most severe stresses. As with nickel alloy steel special treatment is required to attain the maximum strength and hardness. The use of these expensive and dependable steels by conscientious manufacturers trying to produce the best article possible explains to a great extent the rapid improvement of the automobile and likewise its high price.

The grades of steel mentioned are perhaps the most common in automobile construction. Many others, however, are used to some extent. Spring, tool, tungsten and vanadium steels are examples. Enough have been mentioned, however, to give an idea of the variety used.

Brass and bronze are used extensively in the bar-stock form to make many small parts requiring little strength. These parts are nuts, bolts, pins, unions, tubes, bushings, etc. These materials are generally used for their appearance, non-rusting or electrical conductivity properties.

Iron of different grades is used for many of the rough forged parts used about the body if made of wood. Such parts are braces, angles, and rocker plates. Spring clips are usually made of iron and sometimes a few small machined parts.

SHEET BRASS

Sheet brass is used for many of the polished parts, where a finished appear-

ance rather than considerable strength is required. Examples are lamps, horns, bonnet hinges and miscellaneous moldings. Where considerable wear occurs the thick sheet-brass is preferable to another metal plated, as the plating will wear off in a comparatively short time.

SHEET COPPER

Sheet copper is principally used for gasolene tanks, where its pliabilty and toughness makes it an admirable material in which to make secure joints. If the tank is exposed to view, the copper may be polished, giving a finished appearance. Electrical connections are usually made of copper strips or tubes, and copper tubing annealed is frequently used for conveying the gasolene from the tank to the carbureter, as it does not easily spring a leak from the vibration of the car.

SHEET STEEL

Sheet steel is a very useful material for engine bonnets, fenders, dust guards and even complete bodies. Numerous small parts are punched and formed from this material, as it is cheap and easily worked. Most frames are also made of cold-pressed sheet steel.

GALVANIZED IRON

For parts which cannot be painted, and which must not rust easily, galvanized iron is much used. It is an inexpensive substitute for copper in the formation of gasolene and oil tanks. It is also used for drip pans, and covers, under the chassis to protect the working parts from mud and water, and for small parts where rusting is to be avoided.

SHEET ALUMINUM

The use of sheet aluminum for automobile bodies is becoming common on the high-grade cars. It is light, of good appearance, and will not warp or crack. It is also much used for fenders and engine bonnets. It is a more difficult metal to work than sheet steel, as it is not easily soldered, and is stiff to form in shape. On the other hand, it does not rust or corrode, and is not so liable to rattle and be noisy. In general its use is to be preferred to that of sheet steel for the parts mentioned.

MISCELLANEOUS MATERIALS

WOODS

Under this caption will be mentioned the principal materials entering into automobile construction not previously noted. The most common are perhaps the different woods, both hard and soft. The majority of bodies are made of hard wood—oak or ash—with some inserted parts of a different wood such as cherry and mahogany. Other parts are dashes, running boards, filling strips for the pressed steel frames, tools, battery and spark coil boxes.

INSULATING MATERIALS

Insulating materials used for the electric ignition systems are porcelain, mica, fiber, hard rubber and vulcabeston.

UPHOLSTERING AND FINISHING

The body upholstering and finishing requires various leathers and fabrics, such as goatskin, canvas, oilduck, and pantasote. Glass, celluloid, and sheet mica are used for windows and shields to protect the occupants of the car. Curled hair is used to upholster the cushions and seats, and perhaps as many as twenty coats of leads, paints and varnishes are applied to the body and running gear before they are pronounced finished.

Other materials used in miscellaneous places are sheet lead, asbestos, felt, sole leather, steel tubing, wrought-iron pipe, platinum, silk, paraffin, cotton, etc.

The materials noted do not, by any means, comprise all those found in all cars, but are, perhaps, the most common. The list could be extended if a careful canvass were made, but enough are mentioned to give something of an idea of the field the designer has before him from which to select his materials.

A REVIEW OF FORMULAS FOR HELICAL SPRINGS

A New Solution of Certain Problems

BY O. A. THELIN

The principal formula for helical springs is the one given by Prof. F. Reuleaux based upon the fact that the coil in a spring can be considered as a bar, held at one end and influenced by a turning moment at the other, the arm and force of the moment corresponding to the pitch radius and load of the coil.

Let

P = force in pounds

S = ultimate strength of the material for torsion = 4/5 of that for tension

d = diameter of wire in inches

D = pitch diameter of coil in inches

F = deflection of one coil under load P in inches

G = modulus of elasticity for torsion = 2/5 of that for tension

and the formulas given in Kent's Pocket Book, in which the pitch diameter is expressed as the outside diameter less the diameter of the wire, become:

$$P = 0.3927 \frac{S d^3}{D} \qquad (1)$$

$$F = \frac{8 P D^3}{d^4 G} \qquad (2)$$

Assuming the ultimate strength of ordinary spring steel to be 100,000 pounds per square inch for tension and the modulus of elasticity to be 31,500,000 for tension the factors S and G become:

$$S = \tfrac{4}{5} \times 100{,}000 = 80{,}000$$

$$G = \tfrac{2}{5} \times 31{,}500{,}000 = 12{,}600{,}000$$

and formula (1) and (2) become:

$$P = \frac{31{,}500\, d^3}{D}, \text{ nearly,}$$

$$F = \frac{P D^3}{1{,}575{,}000\, d^4}$$

Inserting the value for P in the expression for F, we get two simple formulas for a helical steel spring of *round wire*:

$$P = \frac{31{,}500\, d^3}{D} \qquad (3)$$

$$F = \frac{D^2}{50\, d} \qquad (4)$$

Where P = maximum safe load in pounds.

D = Pitch diameter of coil in inches.

d = diameter of wire in inches.

F = Deflection of one coil in inches under load P.

For wire of square cross section, making the same change in the rotation as before, the formulas in Kent's Pocket Book become:

$$P = 0.4714 \frac{S d^3}{D} \qquad (5)$$

$$F = 4.712 \frac{P D^3}{d^4 G}$$

Comparing the formulas for round and square steel we get the multiplying factors when the cross section is changed from round to square,

for load

$$\frac{0.4714}{0.3927} = 1.2,$$

for deflection

$$\frac{4.712}{8} = 0.589$$

Inserting values for S and G in (5) and (6), and also the value for P in the expression for F, we get two simple formulas for a helical steel springs of square wire:

$$P = \frac{37{,}700\, d^3}{D} \qquad (7)$$

$$F = \frac{D^2}{70\, d} \qquad (8)$$

For phosphor bronze wire, used mostly where corrosion is a factor to be considered, and assuming the tensile strength to be one-half of that of steel, we have:

For round section:

$$P = \frac{15{,}750\, d^3}{D}$$

$$F = \frac{D^2}{50\, d}$$

For square section:

$$P = \frac{18{,}850\, d^3}{D}$$

$$F = \frac{D^2}{70\, d},$$

that is for the same deflection, the phos-

phor bronze spring will carry one-half the load of the steel spring, diameters of coils and wires being equal.

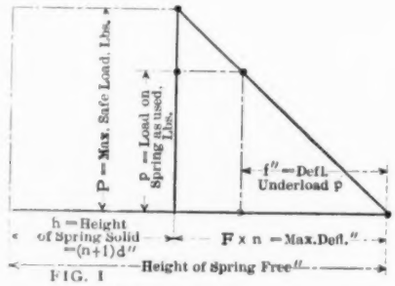
Formulas (3) and (4) give the limit values for load and deflection of the spring. The deflection for any other load can now be readily obtained by a simple diagram, based upon the fact that $\frac{p}{f}$ is always constant, within the elastic limit.

Let n = the number of full coils in spring,
d = diameter of wire in inches,
h = hight of spring solid in inches,
H = hight of spring free in inches,
p = load on spring as used, pounds,
f = deflection under load p in inches;

Then $h = (n + 1)\ d$

and $F \times n = H - h$ = maximum deflection of spring.

Laying out P *max.* and F *max.* to any convenient scale as in Fig. 1, the relation between loads and deflections of the spring can thus be read off immediately, without further calculations.


P = Max. Safe Load, Lbs.
p = Load on Spring as used, Lbs.
f" = Defl. Underload p
h = Height of Spring Solid = (n+1)d"
F x n = Max. Defl."
Height of Spring Free"
FIG. 1

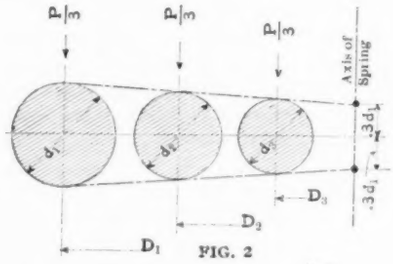


FIG. 2

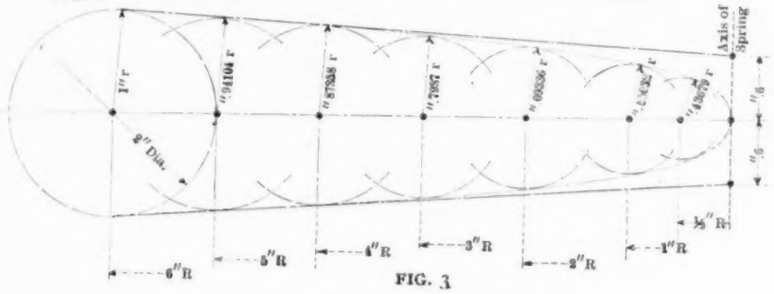


FIG. 3

THE DESIGN OF HELICAL SPRINGS

Where the problem is to design a double or triple spring (two or more concentric springs) each individual spring to carry an equal part of the total load, the following method may be employed with advantage:

Let P = total load in pounds
N = number of individual springs,
D = pitch diameter of outer coil, inches,
d = diameter of wire of outer coil, inches;

then $\frac{P}{N}$ = load per spring in pounds.

Design the outer coil for load $\frac{P}{N}$ from equation (3) draw a line perpendicular to the axis of the spring through the center of the cross-section and offset .3*d* to each side of this line on the axis, as in Fig. 2. From these two points draw tangents to the circular section of the coil *d*, when any coil d_2, d_3, etc. tangent to the two lines will also carry $\frac{P}{N}$ pounds load.

Theoretically, the two tangents will not be straight lines, but form the curve of a cubic parabola. The difference is, however, very slight, as shown in Fig. 3, and need not be considered for practical purposes.

A Possible Opening in Germany for American Laundry Machinery

The following remarks on the above subject were made by Consul-General William F. Wright, of Munich:

"The laundry work done in the United States is generally far superior to that over here, and it is believed our improved machinery would find a ready market in this Empire if properly exploited. It is true that the average capacity of the plants here is small, hand work the rule rather than the exception, and wages low, but up-to-date methods would speedily bring about a change in these conditions.

"Manufacturers of laundry machinery who desire to obtain export business should not depend upon correspondence, catalogs, or other trade literature, written or printed in English, to secure orders. Salesmen, familiar with the German language, manners, and business conditions, and fully able to demonstrate the superiority of the machines should be employed to either solicit orders or establish selling agencies."

At the Bay View merchant mills of the Illinois Steel Company, at Milwaukee, Wis., a horizontal tandem double-acting Allis-Chalmers gas engine, direct connected to a 500-kilowatt 240-volt generator and using blast furnace gas as fuel, is being installed. The conditions which led to this instalment are as follows: For years at this plant, as at other steel plants, the waste gases from the blast furnaces have been burnt under the steam boilers; a demand having arisen for more power, it was obtained by compounding the steam blowing engines, resulting in a saving of gas. As there was also a demand for electricity for general power service, this demand was met by the installation of the gas-engine-driven generating unit, which gave sufficient power. If, however, the gas had been burned under a boiler and a steam engine installed, the plant would not have furnished sufficient electrical power. So the superior economy of the gas engine came in very conveniently.

The monkey wrench seems destined to grow in size and some wrenches have recently been made of dimensions and weights which, a short time ago, would not have been dreamed of; the latest production of the Coes Wrench Company, of Worcester, Mass., for instance, being a wrench having a total length over all of 72 inches, and a total weight of 150 pounds. The jaw of this wrench weighs 33½ pounds; the screw weighs 5½ pounds; the strap weighs 8½ pounds; the key 4½ pounds; and the bar 114. The capacity of this wrench is for a 12-inch opening, and the depth of the jaw is 8 inches. This wrench has been made to meet the requirements of bridge erectors, and it is expected that a number of them will be used in this work.

When the arrangements for the new Union Station in Washington were announced some years ago, it was stated that the tunnel for the southern connections would be operated by electric locomotives; however, the construction has gone ahead without any provision for electric propulsion of trains being evident. Recently it was reported that in the interest of the anti-smoke crusade in Washington, steam locomotives would be prohibited from entering the District of Columbia when the new station is finished. This would mean that Washington, like Manhattan island in the near future, would have all the trains entering it propelled by electricity. The railroad companies, according to recent despatches, have strongly objected to the proposed requirement, alleging that not only would time be lost in changing motive power at the edge of the District, but that an element of danger would be introduced by the interruption. This does not look as if they were at present enthusiastic over electric traction where it is possible to do without it.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

The Use of Engineering Handbooks — Finding Things in "Kent" without Using the Index—Approximate Methods of Figuring often Good Enough

The discussion of engineering handbooks and "things in general" at page 677 was the first thing to attract my attention when I picked up my copy of the AMERICAN MACHINIST this week, and while I can contribute nothing of originality or even of great interest to the discussion, what I have to say may be read with profit by many of the subscribers. I am of the opinion that Mr. Plaisted and probably several thousand more of your readers are not getting all that they might from the use of their handbooks, from a lack of knowledge as to the best way to use them.

For instance Mr. Plaisted mentions two questions which have troubled him, namely, the properties of standard rails and the strength of brass. If he will look in the Carnegie Steel Company's handbook of the edition of 1900, at page 124, he will find the information he seeks in regard to the rails, given in very full and complete form. While the page numbers are different in the different editions, and the information may be of different form in the handbooks of other companies, I am positive that the same information can be found in practically every handbook on steel. In regard to the matter of the strength of brass, which he says he is unable to find in Kent's pocketbook, if he will look up page 321 of the 1900 edition, he will find a very full table, and at page 323, several notes on the subject.

HOW TO FIND WHAT YOU WANT IN "KENT"

The question of why Mr. Plaisted failed in getting the desired information when it was right under his hand, is an interesting one. The reason is, at least in the case of Kent's pocketbook, that he depended upon an alphabetical index for the location of his information, instead of the topical index which the arrangement of the book provides. To explain my ideas of the use of Kent, it is in order for us to go into the arrangement of the book, which is so logical, so simple, and yet so thorough that a wayfaring man, though a fool, need not err in his search for knowledge. Within its pages, as one of my students once expressed it, we have "A complete college education for the insignificant sum of five dollars." If printed in the same form as most of our standard engineering works, the book would become four 600-page octavo volumes, and it is naturally impossible to provide a "fool-proof" alphabetical index for such a body of information as this, particularly when it is in so condensed a literary form. The book, like a dictionary or an encyclopedia, needs only its own arrangement to act as an index, with this difference, that while the arrangement of a dictionary is alphabetical, the arrangement of the pocketbook is topical.

To use the pocketbook intelligently, it is first necessary to make ourselves thoroughly acquainted with the general subjects of which it treats, and the order of its contents. We will suppose that we wish some information as to the cause of, and remedy for, hard scale in a boiler. We naturally seek such information under the main topic "Steam Boilers." As for myself, I never consult an index in my use of Kent, but find that after a little study, and a few weeks' use of the book, one can turn at once to a given subject as easily as to a given page. To those who have not as yet made themselves as familiar as I have with the arrangement of the book, it will be necessary to consult the alphabetical, or preferably the topical index (table of contents), which will be found at the very beginning of the book. By constantly consulting the topical index, an idea will be quickly gained as to the arrangement and scope of the work, which it is impossible to get from the alphabetical index.

In my search for such information without using the index, I turn at once to that part of the book devoted to steam boilers, since I have prepared a thumb index to the book, one marker of which opens to that section. Other markers open to such sections as I most often have use for, such as Iron and Steel, Alloys, Compressed Air, etc. Turning the pages, I find from the page headings that incrustation and corrosion are treated at pages 716 to 720. From an inspection of the headings of paragraphs, I find a method for the removal of hard scale given at page 718. If I am interested in learning how to prevent the deposition of such scale, I will proceed to read all that Mr. Kent has to say on the subject of scale, and find that he refers me further to the subject of Impurities in Water, at page 551. Our friend Mr. Osborne may claim that the air at this point is full of chemical reactions, and therefore unfit to breathe, unless you are a college graduate, but it appears to me very easy to grasp the essential facts that the hard scale is caused by the deposition of lime or magnesium salts, and that the proper remedy is either to use a softer water in the boiler, to use a feed-water heater, or to introduce a few pounds of soda ash with each thousand gallons of feed water.

It is in order at this point to remark that Kent, in common with other pocketbooks, is intended for the use of the college man, and the man who has a smattering of "pure science," as well as those of us who have educated ourselves by the laborious and painful process of trial and error. While the book contains a large amount of "free gold," available to everyone who can read by the aid of a dictionary, there is a good deal of "chemically combined" information, which can only be extracted by the "mining expert" equipped with a knowledge of geometry, chemistry, physics, algebra, and one or two other things which the coming generation is taught in High School. Some of these subjects may profitably be studied from the pages of Kent itself, while others are available to all who can read, in dozens of standard text-books.

To return to our search for information, it may be interesting to find out how I was able to find a table of properties of brass in a few seconds, while Mr. Plaisted is unable to find it at all. I did not bother with the index, and I find that if I had, it would have done me little good. Instead, I looked under "Alloys," in the book itself, and immediately found the heading "Alloys of Copper and Zinc." On the page was the information I sought. If I did not know that brass is an alloy of copper and zinc, I might have looked for it in the alphabetical index, and a reference to page 325 would have informed me of its composition. A few minutes' browsing in the immediate neighborhood of this page gives me enough information to enable me to start a small brass foundry. If I know from experience Kent's method of treating such subjects, it will take but a few minutes' time to find what I want. If I have been using his pocketbook for several years, and do not know his method of arranging information, it is about time that I began to find out, for my own good.

THE UTILITY OF GUESSING. ACCURACY OF CENTER OF GRAVITY FOUND BY BALANCING A TEMPLET

Another matter which has interested me in the discussion of beams, started by Mr. Osborne, has been the general attitude toward guessing. I am accustomed in my work to do a good deal of guessing, and to teach my students how to guess, even when exact results can be obtained by mathematical computation. One of your writers condemns the method of finding the center of gravity of an I section by cutting it out, and balancing it on a point, as lacking in accuracy. As a matter of fact, the accuracy of the method for ordinary sections is very great, the error being only from 1/5 per cent. to 1/10 per cent., if the method is carefully used. There is no particular reason why we should strive for greater accuracy than this when the variation in size of the manufactured product is five to ten times this value, the strength of the material may vary by from 5 per cent. to 40 per cent., and the factor of safety by a similar amount. I never employ the method myself for I sections, because it takes much less time to compute the position of the center of gravity, but I often employ it for irregular sections with great satisfaction.

Guessing, like every other accomplishment, may be reduced to great exactness by means of a little system and common sense, and a good deal of experience. When the proper methods are understood, the subject, which most people are accustomed to regard as singularly inexact and useless, becomes one of great usefulness and accuracy. To give an example, let us suppose that we wish to know the number of sheets in a pile of paper. We may guess at the number, which is a very

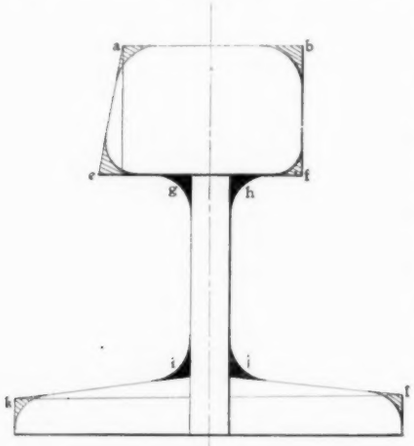


FIG. 1
Approximating the Area of a given Rail Section

crude way, or we can compare the depth of the pile with the thickness of a book having a known number of pages, which is a little better, or we can measure the thickness of a known number of sheets, and compare that with the depth of the pile, or we may select at random from the pile a known number of sheets, and compare their weight with the weight of the pile.

GUESSING CLOSE AT THE PROPERTIES OF A GIVEN RAIL SECTION

For another example, we may take the finding of the area and moment of inertia of a rail section of known dimensions. Such a section is shown in Fig. 1, and is not to be taken as representative of a standard rail. If we divide it as shown, and compute the area of the compound figure, which is very easily done, it is apparent that the error in our computations is equal to the difference in area of the black and the shaded portions, a very

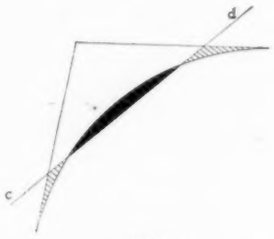


FIG. 2
Reducing the Error Still Further

small quantity, indeed. In the same way, if we find the gravity axis of the section by considering it to be composed of the rectangles and triangles shown, the location of the gravity axis may be found to within a very small fraction of one per cent. Finding the sum of the moments of inertia of the various subdivisions about the gravity axis, the result is the moment of inertia of the rail section, with an error equal to the moment of inertia of the shaded areas *a* and *b*. Should we consider it worth while to eliminate this error, it may be done by constructing a triangle of equivalent area, as shown in Fig. 2, by drawing line *c d* so that the shaded portion cut off of the little space is as nearly as possible equal to the black portion added on. The error in this case is again the difference between the black and shaded areas, a very small proportion of the whole, even though the division is effected by the eye alone. The moment of inertia of the two little triangles so constructed should now be subtracted to get the true moment of inertia of the section. The amount to be so deducted is, for the dimensions shown, about 2 per cent. of the whole quantity.

CONDITIONS FOR CLOSE GUESSING

Guesswork of this kind is permissible and reliable when the following principles are observed: First, that the quantities guessed at shall be but a small proportion of the whole quantity to be estimated. Second, that the errors in the guessing shall be errors in differences, and not in sums, so that they may be small. Third, that the errors shall occur in such a way, that they shall as far as possible cancel one another. Fourth, that the amount of the error shall be either very small, or else of such a form that it is readily computed and allowed for. As an illustration of our principles, I would point out that the sum of all the black and shaded areas in the rail section is a small proportion of the whole section; that areas *e f k* and *l* cancel areas *g h i* and *j*; that the error, which is the sum of areas *a* and *b*, is very small; that it can be approximately computed; and that in doing so, we drew line *c d* in conformity to the second rule, so that the error was the difference, and not the sum of several quantities.

FORREST E. CARDULLO.

Should a Machinist Sit While Working?

The discussion of the above subject, in Vol. 29, Part 1, has led me to experiment with seats for some of my men. All those in my department are allowed stools and they use them whenever the work will permit.

I began by stopping at each machine a few moments every day and getting acquainted with the men, their likes and dislikes, their ideas as to how the tools were working and improvements that some thought could be used to advantage. In the evenings I went to each one before the bell rang to quit and inquired how they were feeling. Some would be pretty tired, others were about ready for their supper and a few were thinking of the good time they would have that night at some party or dance.

Two of the men were running machines which required the use of both hands continually turning the handles and of both feet to brace themselves, both being in a standing position. After pulling those handles around all day and having the weight of their bodies to support also, these two men were quite tired when night came.

After watching them for some time I decided to try stools for those machines as well as for the others. I asked them what they thought of it, and they replied that anything which would not make the work more difficult to do would suit them.

I explained to them that I thought a stool which was just high enough to allow of their weight resting on the edge of the seat, so that they could just reach the floor and have sufficient weight on their feet to properly brace themselves while operating the machines, would be just the thing and that because of their not having to support the weight of their bodies all day, they would not be so tired at night.

I never saw men more pleased than were those fellows after they had used the new seats and found how much they helped them in getting their work out. They both turned out about 10 per cent. more work and felt better for it as it was the means of my getting them a raise in their wages.

I made the change during the early days of spring while the weather was still cool and the ventilating fans were not running. After the weather began to moderate and it became quite warm in the shop, I noticed something whirling around on a horizontal shaft of one of the machines. Going over to the operator I made inquiry and was informed that he had folded a newspaper in several thicknesses making a blade of paper about 6 inches wide and 24 inches long, one end of which he had tucked into the pulley between the arms, using a wad of paper to wedge it in, allowing the remainder of the blade to stick out past the rim of the 8-inch pulley so that it would revolve with the pulley and stir up the air in the immediate vicinity of the machine. After he had started the machine with the paper blades in place he had a nice little breeze right where it did the most good.

Now there was a harmless paper fan making 360 revolutions per minute, and while it looked somewhat queer and out of place, I told him to keep it going while the hot weather lasted. The man next to him doing the same work soon had a fan going too.

There were two men doing good work and lots of it, they each had a fan and a seat, they got out more work and were glad to know that I had taken enough interest in them to make things as easy and pleasant for them as possible.

By George.

An Error in the Bolt and Nut Tables

I have discovered that in most, if not all, of the mechanical hand books the long diameter of the standard 3½-inch hexagon nut is given as 67/64 instead of 67/32 inches.

It was only by the greatest good fortune that an expensive mistake was avoided when this error was detected and perhaps a word of warning in the columns of your paper may save someone else from going wrong on the same thing.

F. W. Collins.

A Collection of Comments

I cannot resist the temptation to comment on some of the articles that have recently appeared in the American Machinist, and particularly on some of those which appeared in No. 47.

PRESSURE ON WORM STEP BEARINGS

There has been an extended discussion with diagrams and mathematics on worm gearing, and among the rest the question has come up as to the pressure on the step by various pitches of screws. Why this question should require anything but a moment's consideration to settle is a wonder. If a worm wheel is pushed around to do a job and it takes 100 pounds push to do it, how will it be possible to get a pressure of more or less than 100 pounds on the step?

As I said in your paper some years ago, "If the most perfect worm gear we can get is a screw and nut—which are about the worst things we have in machinery to wear out—and theoretically the worst worm gear is a Sellers planing-machine drive, which never wears out," why are the pages and books spent on the subject worth while? If one wants a worm gear with all the wearing surface and strength possible it would seem that he might send his blanks to one of the Philadelphia concerns and have them cut—Hindley—or if he wants one that will last always, stick a properly pitched worm in a skew gear and go ahead.

CAST-IRON BEAMS

If it takes all the figuring that has been expended on the problem to determine about Osborne's cast-iron beam, would it not be cheaper to make it of steel and turn to the beam-maker's book for the size; or if it is to be of gray iron anyway, and the man who is to do the figuring has to guess at the two important factors, the unknown strength of gray iron and the factor of safety—which may by different men's opinion vary 20 per cent.—hadn't he better guess at the beam to begin with?

SHRINK FITS

A good example of the mathematician's side of this question was given by one of your contributors some weeks ago. He told about "figuring first and guessing afterward." He assumed, if I remember correctly, that his steel had a modulus of elasticity of a given amount, of which he knew nothing, and judged that 100 degrees of heat was about right; and these two things entered as factors in his problem. As the job came out right he prided himself on his good judgment in relying on the figures.

It was simply a case of shrink fit, which has been done thousands of times by guess with a mighty small percentage of failures, and for the reason that if his allowance had been 50 per cent. less or 200 per cent. more, the job would have been, so far as anyone could tell, just as good.

APPRENTICESHIP

I cannot see that fifty of the largest machine-tool builders telling of the success of their apprenticeship methods has much bearing on the subject, so long as there are five hundred concerns whose failures we know nothing about.

John E. Sweet.

Bond Paper versus Tracing Cloth

For the past two years I have been making all drawings on bond paper, inking in and making blue-prints from them, in fact a pale print may be made before they are inked in. I am fully convinced that the method is a time saver and better than to first make the drawing on detail paper and then trace in ink on tracing cloth.

I had always been used to tracing all drawings on linen, and thought it the only practical way; but when I came in the employment of another company, I found they had always used bond paper and did not care to make the change, so that I had to adapt myself to my surroundings.

My first difficulty was to make a nice arrangement of the parts; having been accustomed to make the drawing almost anywhere on a sheet of detail paper and then shift the tracing to get a good arrangement. All this is time wasted. I soon learned the new method and by using a little forethought was able to place a detail wherever I wanted or make an assembled drawing, that would stay within the border lines, thus obtaining better results than before.

It is almost impossible to do quick work without occasionally smearing a line that is not quite dry. Erasures of this sort may be nicely made on bond paper with a common pencil eraser and some powdered pumice leaving a good surface to ink on.

When a drawing is to be traced on linen unless it is well penciled, with clear and sharp lines, it is hard to see through the tracing cloth. At the best it is more or less a strain on the eyes. With bond paper the lines are in plain view.

Nearly everyone is familiar with the tendency of tracing cloth to become slack and distorted in damp weather, making it difficult to accurately trace the drawing. With bond paper while it may get slack in damp weather, it does so in a uniform way so that by loosening the drawing and re-stretching it the work may go on as before.

Drops of water on tracing cloth leave opaque spots which make white marks on all blue-prints thereafter. On bond paper, as soon as the spot is dry, the paper assumes its original texture.

Bond paper lies better in the drawers and does not curl up as tracing cloth does.

In tracing, the original and cloth are, as a rule, left tacked to the board until the drawing is finished; with the bond paper after the drawing is inked in, or all the mechanical work done, the drawing may be loosened from the board and placed in convenient positions to put in the figures and letters.

Those who have used bond paper speak very favorably of it, which is as a good point as any. W. Hoy Bradley.

The Union Special Machine Company, Chicago, surprised its employees Thanksgiving eve by presenting to each one who had been in its employ three months or more, a sum of money approximating 5 per cent. of his earnings during the past year or such part of a year as he had been with the company.

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Modern Apprenticeship

Though we presented as part of our report of the recent meeting of the A. S. M. E. an abstract of Mr. Alexander's paper, describing the apprentice training school (or shop, or school-shop, or shop-school) of the General Electric Company, at Lynn, the subject is so important to so many of our readers that we feel justified in presenting the paper in full, as we do elsewhere in this issue.

Those of us who have passed through the experience of a regular apprenticeship of the old-fashioned kind will conclude from the reading of this paper that the world, at least part of the machine-shop world, has advanced a long way in these matters. The difference between the systematic, scientifically conducted course of instruction given to apprentices at Lynn, and the catch-as-catch-can, rag-time instruction given to apprentices in most all shops a few years ago, and in the vast majority today, is exceedingly striking.

The fact is that much of the so called apprenticeship system of today is largely humbug and fraudulent.

We know of youths who have within recent years signed articles of agreement with shop owners, and who supposed they were all fixed for learning the trade thoroughly, but who speedily found that foremen, superintendents and others in authority within the shops have ways of effectually nullifying such agreements and do nullify them.

The fact is that when a shop proprietor signs such an agreement he obligates himself to do a thing, for the actual doing of which he usually makes no provision whatever. The doing of the things which he has agreed to do must be done, if at all, by parties who are not concerned in the carrying out of the contract, and whose interests are often, if not usually, against the carrying it out.

Superintendents and foremen are held responsible for results in the shape of work turned out, and the cost of that work. If they fail in these things they hear from it. But who ever heard of one of them being called to account for not having thoroughly instructed an apprentice boy?

If a boy happens to favorably impress one of the shop authorities, he may have the opportunity of being instructed by some of the men, but even then his instruction is apt to be of the most desultory character, and he is taught nothing, or worse than nothing, about the underlying causes of things—the reason why—which, if he is at all interested, and of the normally inquiring mind, he always wants to know.

Many of the shop men who affect to despise "theory," and "theorists," will, in answer to the boy's questions, give him not only theories but entirely wrong theories—theories that set aside all the well established laws of physics and mechanics, and which produce only confusion and darkness instead of enlightened intelligence.

The intelligent boy cannot be happy or enthusiastic under such conditions. But he can be enthusiastic and happy under the conditions described by Mr. Alexander. It is impossible to imagine any youth with the least particle of natural taste for and interest in machinery not being kept fully awake and with his enthusiasm at high pitch in such surroundings and under the direction of men who instead of being entirely engrossed in entirely different things have only one thing to do, i.e., instruct and train; in other words, to coöperate with the boy in the speediest and best possible accomplishment of what he has come to them to accomplish.

For such a shop as the one with which this school is connected we believe the plan followed there is pretty nearly as good as is possible. It will, of course, need modification for other shops differing in magnitude or in other respects, and it might not work so well where for any reason the shop maintaining the school could not hold its graduates. It will be noted that the General Electric Company holds most of its Lynn graduates. The proprietors of a shop who believe they could not hold them should look to the conditions in their shop It will probably pay to change them, regardless of the apprenticeship question. If it is true that a shop with the advantages of having young men in its service who are at home in the town, whose friends and perhaps parents are there, and who are accustomed to the place and its ways, cannot hold them in competition with other shops, there is something wrong that ought to be made right, and nothing can be more certain than that if the shops are to secure the services of high-grade, intelligent young men who are inherently capable of developing into men fitted to carry responsibilities, the shops must not only provide instruction and training for such men, but must make such careers attractive to them—attractive in competition with other careers that are open to high-grade young men, capable of carrying responsibilities.

The Last of the Year, the New

This, for our American readers, the last number of this journal for 1906, marks the end of its twenty-ninth volume. We take the occasion to express the hope that all our readers and friends have enjoyed a merry Christmas, that they are able to look back over the year and its events with at least a reasonable degree of satisfaction and forward to the new year with highest hopes and most pleasurable anticipation.

The year closes in the midst of a period of activity quite unexampled in our pre-

vious history. In this general activity our machine shops have participated to the fullest extent. The new year opens with order books filled to repletion and, so far as can be seen, the machine constructor will have all he can do and more than he can do throughout the new year.

As to our own part in the work we can only say that we expect to keep on chronicling events as they take place and recording, by text and illustration, the advance steps that will be taken.

The editor of a weekly journal such as this must, to a great extent, play the part of an opportunist. He cannot usually make definite plans very far in advance, but must follow the trend of events, present to his readers what comes across his field of vision, and comes in such a way as to make it possible for him to make use of it.

About all we can say for the coming year therefore is that, as in the past, we shall simply do the best we can. However, for the immediate future we have prepared an elaborate series of articles describing and illustrating the naval gun shop at Washington, and we hope to follow with a full account of another, but private, establishment in which similar work is done, and a good deal of other work besides—an establishment which, though famous in its way, and very important, has, up to the present, permitted no account of its works, equipment or methods to be published.

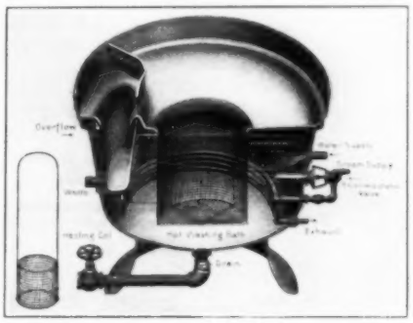
We are especially gratified at the growth of our foreign correspondence. The AMERICAN MACHINIST now forms the principal medium for the exchange of ideas, and of records of experience between the new and the old world's machine constructors. Our recently published articles on the industrial situation in Russia are, we think, far and away the best things that have appeared on that interesting country, and we hope during the new year to be able to present many things of equal excellence pertaining to the machinery industries throughout the world. A happy and a prosperous New Year to all our readers and friends!

The establishment of a department of correspondence instruction by the University of Wisconsin seems to mark the beginning of a new era of development in the educational influence of State institutions, for it seems altogether probable that, if this plan of correspondence instruction designed for the citizens of Wisconsin works well, then other State institutions will be, by public sentiment if not otherwise, compelled to take up the same work. It is announced that even the languages will be taught by this institution in much the same manner as they are taught by the Scranton schools; that is, by the aid of the phonograph, supplementing the text book. The experiment will be watched with interest by everyone interested in educational matters.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A SODA AND POTASH KETTLE

The illustration shows a soda kettle for cleaning oil, grease, paint, etc., from machine parts. Where steam is available the coil is coupled to a supply pipe, the thermostatic valve automatically regulating the amount of steam admitted to the coil and consequently the temperature of the bath. The kettle is provided with a removable cover and an overflow in case the contents should boil over. The top of the overflow is open, forming a slop basin into which the slops from the shop can be thrown. A wire basket for small parts is provided. In case no steam is available the kettle is heated by gas, the temperature of the water being controlled by thermostat. This kettle is made in two sizes; 40 and 60 gallons capacity, by the Manufacturing Equipment and Engineering Company, Boston, Mass.



A SODA AND POTASH KETTLE

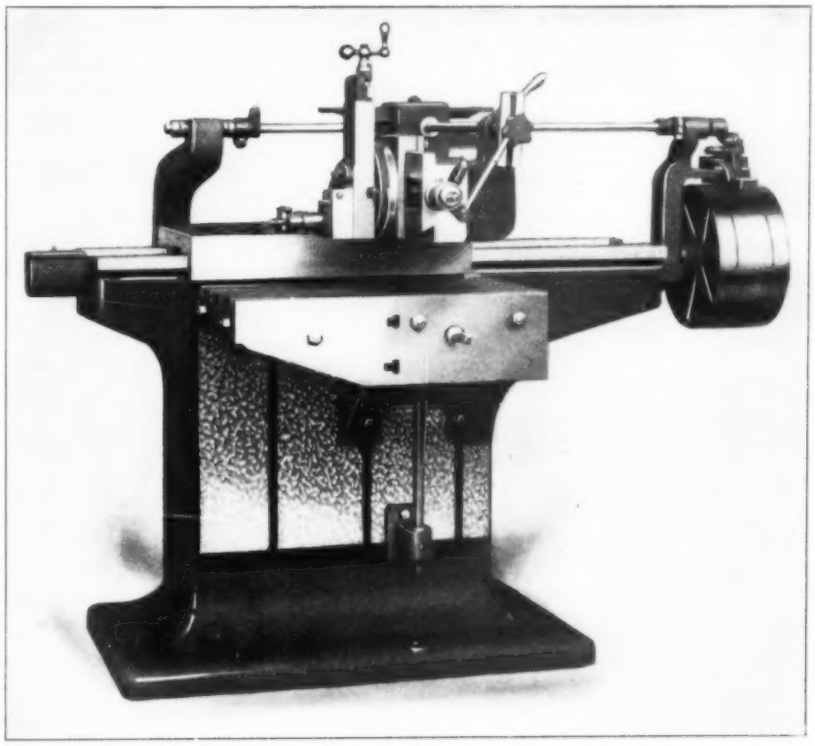
AN OPEN-SIDE SHAPER

The illustration shows an open-side shaper representative of a line of similar tools of which the one here described and illustrated is the smallest.

The machine is driven by a screw 2⅛ inches in diameter working in a bronze nut and without any gearing between the pulleys and the screw.

The saddle is provided with a taper gib to take up wear. The cross feed is by power or hand and is adjustable. The down feed is by hand.

The reversing mechanism consists of cams on the saddle which come in contact with adjustable dogs on the rod. These cams turn the rod which reverses the machine and actuates the cross feed. The table raises and lowers by means of a crank handle. Ball thrusts are provided for the driving and table-elevating screws. The supplementary table may be removed and work bolted to the side of the table or the table may be entirely removed and



AN OPEN-SIDE SHAPER

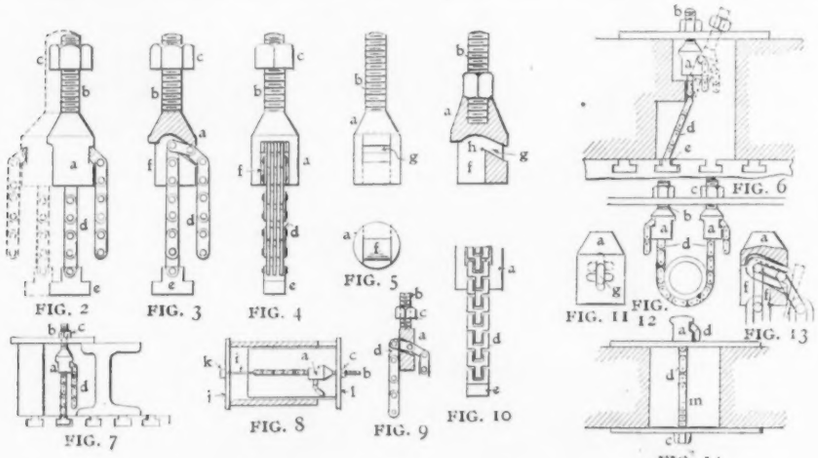
work may be secured direct to the column. This machine will shape a surface 30x15 inches. Maximum distance from the head to the table 15½ inches. Down feed of tool slide 6½ inches. Weight of the machine and countershaft 3450 pounds. This open-side shaper is built by the Cincinnati Shaper Company, Cincinnati, Ohio.

SOME SMALL TOOLS—A FLEXIBLE BOLT

How often it is necessary to bend a bolt to accommodate it to the work when

FIG. 1. A FLEXIBLE BOLT

clamping a job to the planer, boring mill or other machine table, but the flexible bolt shown at Fig. 1 needs no bending and can be shortened or lengthened to suit any conditions that may arise. The line cuts Figs. 2, 3, 4, 5, 9, 10, 11 and 13 show the construction of the flexible bolt and



CONSTRUCTION AND APPLICATION OF THE FLEXIBLE BOLT

a variety of chains that may be used for its flexible body. Fig. 6 shows it taking the place of a bent bolt; Fig. 7 as a straight bolt; Fig. 8 shows it being used to draw a sleeve into a cylinder, the chain being shortened as the work progresses; Fig. 12 shows its use as a U bolt. Many other applications are possible.

A PIPE WRENCH

The pipe wrench shown in Fig. 15 is made of steel throughout. The jaw *A* is pressed against the body *B* by the spiral spring *C*. There is sufficient space at *D* to allow the jaw *A* to swing on the fulcrum pin *E* to the position shown by the dotted lines. This, as will be seen, is ample to allow the jaw to clear the work and readily release it. These wrenches are made in sizes from 10 to 24 inches.

A RATCHET WRENCH

Fig. 16 shows a handy ratchet wrench, both right and left hand. The ratchet sheave *A* has a piece of wire *B* bent

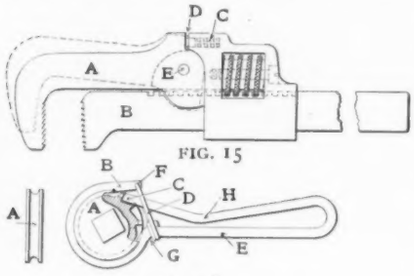


FIG. 15

FIG. 16

A PIPE WRENCH AND A RATCHET WRENCH

around it, as shown. One end of the wire at *C* forms the spring pawl. A small hole is drilled in *B* at *F* and a wire *D* is passed through and twisted around at *G* to hold the two together. When the strain comes on the pawl *C*, the point *H* moves till it interferes with and is backed up by the wire *B* at *E*.

These ratchet wrenches are made with both square and hexagonal holes suitable for set screws, automobile tire-lug nuts, etc., etc.

The articles described are made by Patterson, Gottfried & Hunter, Ltd., 146 to 150 Centre street, New York.

A MOTOR-DRIVEN GRINDER

The Bridgeport Safety Emery Wheel Company, Bridgeport, Conn., has brought out a tool grinder which carries an emery wheel 36 inches diameter by 4 inches face. The spindle is driven through gearing by a 5-horse-power motor. The spindle speed is 425 revolutions per minute. The gearing is covered to avoid accidents. The machine requires a floor space of 30x47 inches and weighs 2650 pounds.

New Publications

"Turbine Water Wheel Tests and Power Tables." By Robt. E. Horton. 136 6x9-inch pages, with 33 illustrations and numerous tables. The Government Printing Office, Washington.

This pamphlet, which is water supply and irrigation paper No. 180 of the Geological Survey, is primarily a reprint of the results of water-wheel tests by various observers, together with such supplementary tables, diagrams and formulas as are required for the intelligent use of the tables. The primary object of the paper is to supply information required in the work of the Geological Survey where the turbine is used as a water meter in gaging streams, and also to furnish information from which the power developed at mills can be determined from the sizes and types of water wheels used. Inasmuch as some of these turbines of which tests are included are no longer built or cataloged, it is believed that the tables will be useful in determining questions of water rights. A chapter on the selection and arrangement of turbines in power plants makes the pamphlet of service to turbine users apart from the tables which give the results of tests.

"Universal Dictionary of Mechanical Drawing." By George H. Follows. Sixty 11x8-inch pages with 45 illustrations. The Engineering News Publishing Company. New York. Price. $1.

This volume is the outgrowth of a paper on mechanical drafting in the modern drafting room which was read by the author before the Engineers' Society of Western Pennsylvania, and republished in several periodicals, including our own, in 1903. So much interest has been expressed in the paper that it has been expanded into the present volume. Its aim is to secure reasonable uniformity in the drawings made by different men in different places, and the adoption of its conventions would undoubtedly lead to that very desirable end. Of the various chapters, the one on dimensioning appears to us to be the most useful, as it is in this particular that so many draftsmen fail. It is a common thing to see drawings which are covered with a wilderness of figures which are so badly arranged, to say nothing of some of those most needed being missing, as to make them a trial to all who have to use them. The ideas set forth on this subject are sensible and practicable, and are worthy of the attention of every ambitious draftsman.

Personal

Hans Renold, of Manchester, is on the way for a short visit to this country.

If our friend signing himself "D. Phool" will inform the editor what particular asylum he is confined in he may hear of something to his advantage.

S. H. Bullard, who has been connected with the sales department of The Bullard Machine Tool Company for the past six years, has been appointed sales manager.

At a meeting of the directors of the Yale & Towne Manufacturing Company, Stamford, Conn., Frank H. Taylor was elected a vice-president of the company. Mr. Taylor was for several years vice-president of the Westinghouse Electric & Manufacturing Company and prior to his connection with that concern he was for seven years manager of Yale & Towne's Philadelphia house.

A. O. Backert, formerly Pittsburg editor of the *Iron Trade Review*, and later Western editor of the *Iron Age*, with headquarters in Chicago, has accepted the position of editor to our excellent contemporary, *The Foundry*. Mr. Backert has a wide acquaintance among foundrymen, and was prominent in the work of the Pittsburg Foundrymen's Association for several years.

H. M. Lane, who has been the editor of *The Foundry* since October, 1903, severed his connection with that paper, January 1, to engage in the practice of consulting foundry engineering with headquarters in Cleveland. He also expects to have New York connections, and will be in a position to advise on all classes of foundry construction and foundry metallurgy. He will continue his position as secretary of the Foundry Supply Association for the present, and devote a much larger amount of his time to the work of the association than was possible under the former arrangement.

Obituary

Edward P. Bullard, of Bridgeport, Conn., president of the Bullard Machine Tool Company, died in Braidentown, Fla., December 22. He had been suffering from heart trouble for two years. He was 65 years old.

Business Items

The Warren Axe and Tool Company, of Warren, Pa., which is a large manufacturer of axes and logging tools of all kinds, has recently acquired the patents and equipment of the American Drop Forging and Tool Company, of Wayland, N. Y., having moved the plant to Warren, Pa. New and modern buildings have been constructed of concrete throughout, and as machinery of the latest improved type has been installed, the firm is now in a position to turn out the "American" pipe wrench and other patented specialties and drop forgings in a satisfactory manner.

Manufacturers

The Reading (Penn.) Radiator Company is enlarging its plant.

The Epeneter Cornice Works, Omaha, Neb., will erect a $10,000 factory.

The Graham Nut Company, Pittsburg, Penn., will extend its plant.

The Atlas Drop Forge Company, Lansing, Mich., will erect a new plant.

The Detroit (Mich.) Woodenware Company will build a new factory.

The Athol (Mass.) Paper Box Company will build a three-story addition.

The Hattiesburg (Miss.) Traction Company will erect a new power plant.

The Syracuse (N. Y.) Safe Company, is planning to build a large factory.

The Gates Foundry Company, Wilkes-Barre, Penn., will build an addition.

The Dean Electric Company, Elyria, Ohio, has reorganized and will double its plant.

The Jetter Brewing Company, Omaha, Neb., will erect a bottling works to cost $35,000.

Austin Simkins, Schenectady, N. Y., will build a new lumber mill at a cost of $15,000.

The Standard Steel Car Company will move its plant from Butler to New Castle, Penn.

The Mutual Ice and Cold Storage Company, Topeka, Kan., will double the capacity of its plant.

The Waverly (N. Y.), Sayre and Athens Traction Company will erect a new power plant.

The Alston Stone Machine Company, Endicott, N. Y., will double the capacity of its plant.

The Hightower Box and Tank Company, Atlanta, Ga., will build a new and larger plant.

Kahlenberg Bros., gas engine manufacturers, Two Rivers, Wis., will build a new plant.

The Nicholson File Company, Providence, R. I., has taken out a permit to erect an addition.

The Union Brake Shoe and Foundry Company, Chicago, Ill., will erect a plant in Denver, Colo.

Kelley & Kennedy, foundrymen, Oneida, N. Y., will form a stock company and double its output.

Bridgman Bros., Philadelphia, Penn., plumbers' supplies, has let contract for a large addition.

The Buffalo (N. Y.) Brake Beam Company will move to West Seneca where a new plant will be erected.

The Waterman Motor Company, Detroit, Mich., has let contract for the construction of a new factory.

The Delaware Hard Fibre Company, Wilmington, Del., will erect a plant to employ 300 men at Stanton.

The Smith-Post Company, Milwaukee, Wis., manufacturers of cement machinery, will erect a new factory.

The Standard Foundry Company, Cleveland, Ohio, has had plans prepared for an addition to its plant.

The Card Gummed and Coated Paper Company, Nashua, N. H., will erect a new boiler house at a cost of $25,000.

The Portage Iron and Machine Company, Portage la Praire, Manitoba, contemplates the installation of a wire-making plant, also an up-to-date boiler-making plant, and would like catalogs and price lists of machinery for the equipment of such plants.

Catalogs

Buffalo Forge Company, Buffalo, N. Y. Catalog of centrifugal pumps. Illustrated. 24 pages, 3½x6½ inches, paper.

Gisholt Machine Company, Madison, Wis. Catalog of universal tool grinder. Illustrated, 8x10 inches, 23 pages, paper.

J. G. Blount Company, Everett, Mass. Catalog No. 10, describing grinding and polishing machinery and speed lathes. Illustrated, 6x9 inches, 31 pages, paper.

Heinrich Dreyer, Kaiser Wilhelmstrasse 47, Berlin, Germany. Catalog of American machine tools handled by this concern. Illustrated, 6x9 inches, paper.

Queen & Co., Inc., Arch and Eighth street, Philadelphia, Penn. Catalog of thermometers and meteorological instruments. Illustrated, 6½x10 inches, 170 pges, paper.

The Fulton Machine and Vise Company, Lowville, N. Y. Catalog C, describing Reed universal, vertical and horizontal swivel vise. Illustrated, 3½x6 inches, 14 pages, paper.

Frank Toomey, 127-131 North Third street, Philadelphia, Penn. Catalog of metal-working machinery carried in stock by this company. Illustrated, 6x9 inches, 29 pages, paper.

The New Era Mfg. Co., Kalamazoo, Mich. Booklet entitled "All About Babbitt Metals." This contains information which ought to be of value to the user of such metal. 3½x6½, 20 pages, paper

The Smith Countershaft Company, Boston, Mass. Catalog describing one belt reversing countershaft for driving and reversing engine lathes, screw machines, etc. Illustrated, 6x9 inches, 23 pages, paper.

The Clark Automatic Telephone Switchboard Company, Providence, R. I. Catalog of Interior Systems and Wall and Desk Sets for office and factory use. Illustrated, 6x9 inches, 12 pages, paper.

Geo. V. Cresson Company, Philadelphia, Penn. 1906 catalog of power transmitting machinery. This is very complete, containing a number of tables and other information. Illustrated, 6x9½ inches, 350 pages, cloth.

The Bridgeport Safety Emery Wheel Company, Bridgeport, Conn. 1907 catalog of emery wheels and grinding machinery, belt or motor driven with direct or alternating current motors. Illustrated, 6x9 inches, 95 pages, paper.

The New Process Raw Hide Company, 500 Plum street, Syracuse, N Y. Catalog of different styles of gears with information regarding New Process noiseless pinions and methods of treating the hide for same. Illustrated, 3½x5½ inches, 86 pages, paper.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith Co., Columbia, Pa.

Cox Computers. 75 Broad St., New York.

Universal Test Indicator circulars free. H. A. Lowe, Lock Box 146, Cleveland, O.

Steel case-hardened by modern methods. Boston Gear Works, Norfolk Downs, Mass.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

A new patent for sale—An adjustable, automatic, hollow-block machine. Address 34 Main street, Lestershire, New York.

Wanted — Medium weight specialties to build, or will buy or pay royalty for good patented machine or tool. Box 424, AM. MACH.

Will exchange four-cylinder touring car for screw-cutting lathes, milling machine, shaper and other modern machines. Box 466, AM. M.

Wanted—Upright drills for sale in Great Britain, France and Italy. Will carry large stock. Apply Box 456, AMERICAN MACHINIST.

Estimates given on machine work, patterns and designing in all branches. Address Greenfield Steam Engine Works, Harrison, New Jersey.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Technical men everywhere in spare time. No goods to sell; no expense; professors, draftsmen and literary machinists thus far appointed; state experience. Box 334, AM. M.

Wanted—Woodworking and metal-working machinery; must be modern and in first-class condition; send in description and prices asked. Rapid Motor Vehicle Co., Pontiac, Michigan.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

The annual meeting of the stockholders of the Hill Publishing Company, for the election of five directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company in the Hallenbeck Building, 497-505 Pearl street, Borough of Manhattan, New York City, N. Y., on Monday, January 14, 1907, at 12 o'clock noon.

Dated, New York City, Dec. 17, 1906.

F. R. LOW, Secretary.

Business Opportunities

Active business partner wanted for established paying company. Salary $2000 to $4500. Investment of $5000 to $25,000 necessary. Investigation and audit allowed. Business Opportunity Co., 1 Union Square, N. Y.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two second-hand cupolas in first-class condition; shells 72"—82" in diameter and about 40 feet high. Box 333, AM. MACH.

For Sale—A complete line of planer patterns, covering sizes from 18" up to 72", inclusive, and patterns for special sizes; also drawings and tracings for the same. Will sell at a low figure, as we have gone out of business. Address Box 453, AMER. MACH.

A machine shop situated in Worcester, Mass.; about 20,000 square ft. manufacturing floor space; about 3000 square feet storage floor space; 18,569 square feet land, corner lot; first-class railroad facilities; complete power plant almost new; full line main shafting with pulleys. Price right. Box 464, AMERICAN MACHINIST.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

GEORGIA

Position as superintendent or general foreman on engines, air compressors, and electrical machinery. Box 432, AMER. MACHINIST.

ILLINOIS

Factory manager—Mechanical engineer with high-class executive and business ability desires position as manager of manufacturing department of any first-class concern in the machinery line; am married, 33 years of age, and have a family; have 12 years' experience in all departments of the manufacturing business and can submit excellent record; can develop new articles, make tools, dies and jigs, etc., handle men, organize shop systems and do everything necessary to produce results; will consider only a first-class proposition, either from an established concern or from capital desiring to enter the manufacturing business; references required and given, and details gone into at interview only. Address "F. H. S.," AMERICAN MACHINIST.

IOWA

Mechanical engineer wants to get charge of a line of work with good people; $1600. Box 387, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Position as foundry foreman with some reliable firm; sober man, well up in machinery castings and cupola practice and mixing iron by analysis. Address Box 462, AMERICAN MACHINIST.

All-around tool and diemaker—15 years' experience on high-grade interchangeable work, American, age 38, married—would like position as foreman toolmaker. Box 450, AMERICAN MACHINIST.

Wanted, by an American man, who has had 17 years' experience as tool and diemaker, and who is superintendent of a shop at the present time, a position as foreman or superintendent; best of references given. Box 467, AMERICAN MACHINIST.

MICHIGAN

Superintendent wishes to make a change; experienced in the commercial manufacturing of both small and medium machinery with the interchangeable system; a systematizer and cost reducer; have held the following position: toolmaker, tool designer, foreman and master mechanic; willing to go anywhere; New England preferred. Address Box 403, AMERICAN MACHINIST.

NEW JERSEY

Salesman—A position as salesman for machinery and machinery specialties; 15 years' experience; age 35. Box 441, AM. MACH.

General foreman in large shop desires position as superintendent or master mechanic; technically educated and strictly up-to-date. Box 430, AMERICAN MACHINIST.

Wanted—A responsible position as chief draftsman, or assistant superintendent preferred, by a capable young man with eight years' experience designing engines, air compressors, steam turbines, jigs, tools and fixtures and machine tools; at present head draftsman and checker over 10 men; systematic and good executive ability in drawing room and shop; best references; location immaterial. Address "Johnson," AM. MACH.

NEW YORK

Mechanical engineer—25, graduate, good theoretical knowledge and practical ideas—desires position. Box 449, AMER. MACHINIST.

Wanted—By mechanical engineer, position as superintendent or manager of machine works; special ability in installing systematic methods of manufacture. Box 317, AM. M.

Situation wanted by machinist toolmaker; 20 years' experience; speak English and German; first-class references; large experience; can take charge of toolroom. Box 448, AMERICAN MACHINIST.

Wanted—Position in New York City or vicinity as purchasing agent by graduated mechanical engineer, who wishes to spend half of each day on this occupation. Box 463, AMERICAN MACHINIST.

First-class machinist, diemaker, designer and inventor; been designing special and automatic machinery, jigs, tools 30 years; experience handling men, 25 years here and abroad; only New York or Brooklyn. Box 454, AMERICAN MACHINIST.

Position as manager of works by mechanical engineer; held similar positions past six years in large modern plants; high standing in executive and mechanical ability, experience and energy; irreproachable character; good reason for change. Address Box 425, AM. M.

Position as works manager with company employing about 200 men; am desirous of associating with a company that wants to cut the cost of manufacture and increase their output; excellent executive ability, successful in the handling of men. Box 374, AM. MACH.

PENNSYLVANIA

Mechanical engineer — 27, with technical education, experienced in shop and office—desires position as assistant to superintendent or master mechanic of some manufacturing concern; any location. Box 461, AM. M.

TEXAS

Wanted — Position as superintendent of good-sized jobbing shop; 12 years' experience planning, estimating and installing repairs for break-downs. I can lay out any kind of breeching; am a practical patternmaker and draftsman, with a general knowledge of all mechanics. Address Box 468, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Experienced toolmakers on gages, fixtures and dies. Address, giving particulars of experience and wages desired, Ross Rifle Co., Quebec, Canada.

Wanted — Draftsman with experience in sawmill and pulp machinery; state age, experience and salary expected. Address Box 419, AMERICAN MACHINIST.

Wanted — Young mechanical draftsman; technical graduate preferred; ability required to design light machinery; state age, salary expected and experience. P. O. Box 140, Hamilton, Canada.

Wanted—First-class toolmakers and lathe hands; those accustomed to punch and die work preferred. The Northern Electric and Mfg. Co., Ltd., corner Notre Dame and Guy streets, Montreal, Quebec.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

INDIANA

Increasing force—Wanted, ten lathe men; also three toolmakers; good wages; open shop; steady employment. Western Motor Co., Logansport, Ind.

IOWA

Wanted—High-class mechanic to take charge of tool department of about 15 men in a duplicate-part factory in a small Western city; state experience and length of service with previous employer. Box 411, AMER. MACH.

MASSACHUSETTS

Bright young man who has had experience in making and repairing Saunders dies. Box 447, AMERICAN MACHINIST.

Wanted—Adjuster on envelope machine—one for fast machines, one for Reays—to take care of our increasing business. Box 465, AMERICAN MACHINIST.

Wanted — A-1 hardener capable of taking charge of department; must understand hardening and tempering high-speed tools; steady work; references required as to ability. Box 446, AMERICAN MACHINIST.

Wanted—First-class mechanic with executive ability to speed up lathes, drills, screw machines, millers, etc., to maximum efficiency; must be a man with ideas, a hustler, willing and able to demonstrate efficiency of new speeding to the men by actual operation; a gilt-edge position for the right man; state fully experience qualifying for this place and give references. Box 87, Sprinfield, Mass.

MICHIGAN

Foreman die and tool department—Wanted, a man capable of managing this department in a large factory in southern Michigan, manufacturing steel ranges, summer cook stoves, etc.; must be able to design and make all classes of forming, drawing, perforating and punching dies and special power tools; will also act as master mechanic for entire plant; successful applicant must show actual experience as foreman in this class of work; liberal salary for right man. Address Box 455, AMERICAN MACHINIST.

MISSOURI

Wanted — First-class assemblers; prefer those having had experience on adding machines or typewriters; give references. Universal Adding Machine Co., St. Louis, Mo.

Wanted—Machinists, electricians, engineers

and firemen, do you want to "get wise?" Send for 52-page pamphlet containing questions asked by different Examining Boards; sent free. Geo. A. Zeller Book Co., 53 South 4th street, St. Louis, Mo.

Experienced superintendent, familiar with general sheet-metal work and fire-proof windows; take full charge of factory; permanent position for first-class man; state experience and salary wanted. Address H. W., AMERICAN MACHINIST.

NEW JERSEY

Wanted—Machinist to act as assistant foreman of repair shop; good opportunity. Apply Atha Steel Casting Co., Newark, N. J.

Wanted—Lathe, planer, vise and machine hands; good wages for first-class men. The Standard Motor Construction Co., 180 Whiton street, Jersey City, N. J.

Wanted—Two good mechanical draftsmen; steady positions; location near New York; state age, wages and full particulars. Address Box 457, AMERICAN MACHINIST.

Wanted—To contract for a large part of our duplicate engine parts with responsible firms, equipped with modern machinery. The Standard Motor Const'n Co., 180 Whiton St., Jersey City, N. J.

Wanted — Foreman grinding department, operating mostly Landis grinders; first-class equipment, modern shop, Newark, N. J.; state experience and wages expected. Box 452, AMERICAN MACHINIST.

Wanted—Tool, die and instrument makers accustomed to accurate, complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

Foreman over 20 machinists, making light machinery and electrical goods in plant employing 90 men; live city in Jersey, 20 miles from New York; state experience and salary. Box 451, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted—Reliable, first-class draftsman and designer, capable of taking charge of several others; one used to printing machinery preferred; position permanent if satisfactory. Adress, stating experience, age, references and salary, Box 458, AMERICAN MACHINIST.

As we are continually adding to our departments, we have openings for men familiar with engines and pumping machinery; we require lathe, planer, shaper, drill and vise hands, also erectors for inside and outside work; good pay and steady work to good men. Address communications to Henry R. Worthington, Harrison, N. J.

NEW YORK

Wanted — Experienced draftsmen, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 20-24 Ryerson St., Brooklyn, N. Y.

Wanted after Jan. 1, 1907, some competent millwrights; applicants must state wages expected and when they can start work. Address A. A. P. C. W., Alsen, Greene Co., N. Y.

Wanted — Immediately, machinists; applicants must state experience, wages expected, and time when they can commence work. Apply to A.A.P.C.W., Alsen, Greene Co., N. Y.

Wanted in January—Competent mechanics capable of lining up heavy machinery and shafting; applicants will please state wages desired. Apply A. A. P. C. W., Alsen, Greene Co., New York.

Several mechanical draftsmen wanted; must have had at least 4 years' actual experience; good salaries to good men; give particulars; location New York City. Box 460, AMERICAN MACHINIST.

Wanted—Competent superintendent for a manufacturing plant within 50 miles of New York City; please give full information as to previous experience, together with references amount of salary, etc. Address "A. D.," AMERICAN MACHINIST.

Wanted—Man with actual experience in grinding wafer blades for safety razors; must be able to take charge of that department; and be able to design machinery for doing work; good wages for right man. Hapgoods Sales Co., 305 Broadway, New York.

Wanted—A draftsman on small electro-mechanical apparatus; one with shop practice, and who is familiar with the use of tools for manufacturing duplicate parts in large quantities; state age, experience and salary. Address Box 459, AMER. MACHINIST.

Foreman wanted—Must thoroughly understand every detail of planer and boring-mill work. We do not wish experimental man, but one who has had experience, who knows how to go ahead without a leader; to such a permanent position will be given and best of wages paid. Address, with full particulars references, etc., "T. J.," AMERICAN MACH.

OHIO

Wanted — First-class designing draftsman familiar with automatic machinery and power punches; steady position to capable man. Box 388, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted—Competent man as foreman of shop and to take charge of general repair force in large manufacturing plant. Must be able to handle men. In replying, give age experience, references and salary required Address P. O. Box 865, Cincinnati, O.

PENNSYLVANIA

Wanted—Machinist to work on fine tools, capable of getting out new devices; good opportunity to right man. E. G. Smith Co., Columbia, Pa.

Wanted — Experienced mechanical draftsmen for general machinery; men experienced in heavy pumping machinery preferred; location, eastern Pennsylvania. Address "Mechanical," AMERICAN MACHINIST.

Wanted—First-class machinists for floor work; must be capable of erecting machines outside the shop and demonstrating; state actual experience in such work. Apply to Stoever Foundry and Manufacturing Co., Myerstown, Pa.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

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Hill Publishing Co., New York.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. & Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.

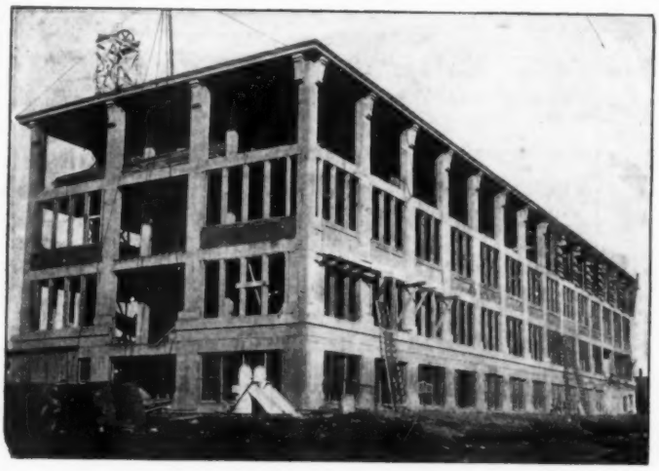
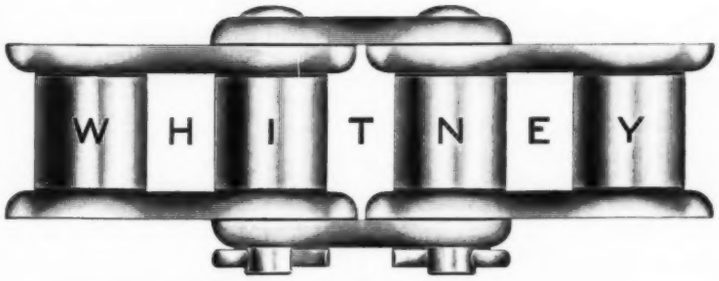
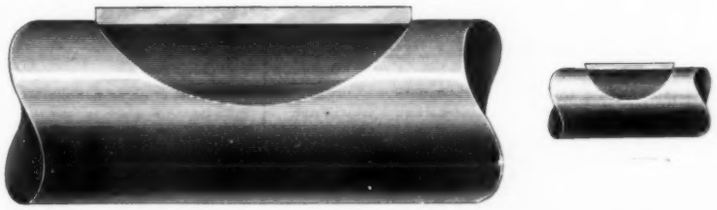


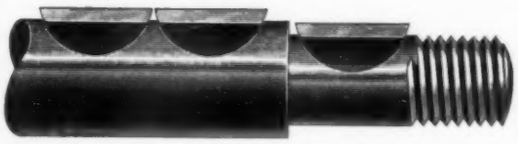
PHOTO TAKEN NOVEMBER 1906.

This cut gives an idea only of our new fire-proof factory building which we believe will be the finest and most complete in existence for the manufacture of High Grade Driving Chains.

We have commenced to move and will operate both plants, old and new, until we are fully settled so our production may be steadily increased with no interruption. We are making many improvements in methods and equipment which will greatly benefit our customers.







"Whitney" Chains, HAND AND WEIGHT FEED MILLING MACHINES, and The Woodruff Patent System of Keying

Are now Standard with most American Builders of Machinery, Automobiles, Commercial Cars, etc.

The Whitney Mfg. Co.
Hartford, Conn.

Boosters—*Continued.*
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co, Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington,
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Wks., Boston, Mass.

Carborundum
See Grinding Wheels.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.
Nolte Brass Co., Springfield, O.
Phosphor Bronze & Smelting Co., Philadelphia, Pa.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Hopson & Chapin Mfg. Co., New London, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks., Boston, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K. Cincinnati, Ohio.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co. Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Tool Co., Cleveland, O.

Chucks, Lathe—*Continued.*
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
National Tool Co., Cleveland, O.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Clutches, Friction
American Tool & Mach. Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Mietz, August, New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.
Chapman & Co., J. B., Springfield, Mass.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
Evans Friction Cone Co., New Center, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., New Center, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Evans Friction Cone Co., New Center, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, O.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

BROWN & SHARPE MFG. CO.

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Quality the feature of every Cutter stamped B. & S. Mfg. Co.

Whether Cutters are desired for Heavy or Light Milling, the design, material and workmanship in every B. & S. Cutter is of such Quality that it will pass the most rigid test and meet all the requirements within its capacity.

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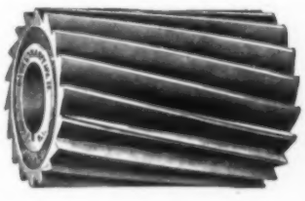


Cutter List sent upon application to any address. See page 26

Crushers
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuue, Iowa.
Becker - Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bertram & Sons Co., Ltd., John. Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-Off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Cyclometers
Veeder Mfg. Co., Hartford, Conn.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos L., New York.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Boston Tool Co., Cambridge, Mass.
Kent & Co., Edw. R., Chicago, Ill.
Wade Machine Co., Boston, Mass.

Dies, Sub-Press
Risdon, S. A., Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Keuffel & Esser Co., New York.
Obermayer Co., S., Cincinnati, O.
Rich, J. & G., Philadelphia, Pa.

Drawing Materials
American Tracing Cloth Co., New York.
Keuffel & Esser Co., New York.
Rich, J. & G., Philadelphia, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Mach. Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote, Burt & Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fichburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.

Drilling Machines, Radial —*Continued.*
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
National Separator & Machine Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cin., O.
Foote, Burt & Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
Chisholm & Moore Mfg. Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Heald Machine Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

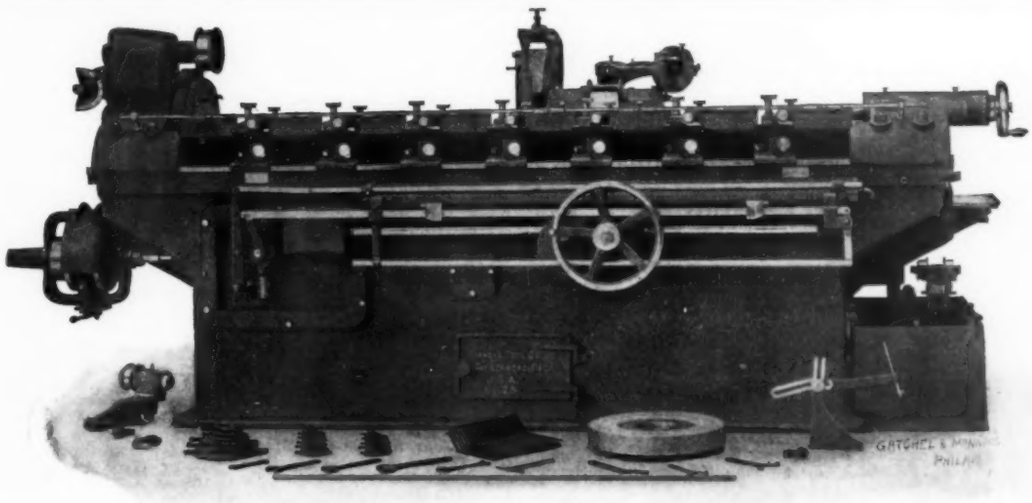
Engineers, Consulting, and Mechanical
Dodge & Day, Philadelphia, Pa.

Engineers, Electrical
Crocker - Wheeler Co., Ampere, N. J.

Engines, Automobile
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Foos Gas Engine Co., Springfield, Ohio.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
New Era Gas Engine Co., Dayton, O.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Oil
Mietz, August, New York.



A LANDIS MEANS REAL PROFITS TO YOU.

Profits you are going to see and feel from the time you install it. Because it takes a great number of pieces you are now doing on the lathe and does them a lot more economically.
To illustrate our meaning: 50 shafts 1½" diameter, 8 ft. long with key-way the entire length (ground after key-way is cut) .050" diameter, was removed, size within .0005" variation limit, in 1¼ hours.

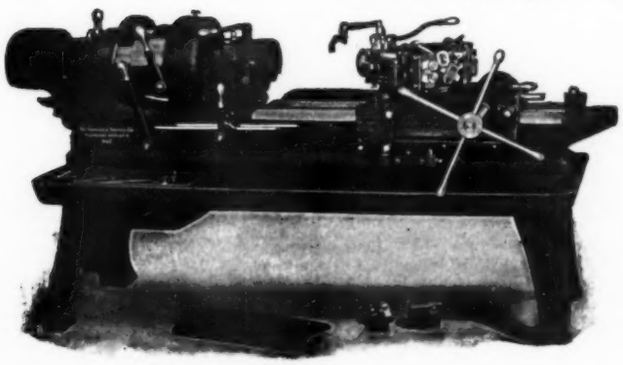
LANDIS TOOL COMPANY, WAYNESBORO, PA., U.S.A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, O., and 933 Monadnock Block, Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

Warner & Swasey Turret Lathes always

Represent all that makes for QUALITY in machine tools—*Hollow Hexagon Turret Lathes* represent the highest development in this class of machine tools.

**The detailed particulars are interesting—should interest you
Will be sent upon request—or representative will call.**



The Warner & Swasey Co.,

Cleveland, Ohio, U. S. A.

Turret Lathes and Brass-Working Machine Tools

FOREIGN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg and Stockholm. Alfred H. Schutte, Cologne, Paris, Brussels, Milan. Williams & Wilson, Montreal. A. R. Williams Machinery Co., Toronto.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay & Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube
Nicholson & Co., Wm., Wilkesbarre, Pa.

Fans, Electric
Boston Blower Co., Hyde Park, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers
Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps
Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Co., Shelton, Ct.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N.Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Sheldon, Conn.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon Co., Worcester, Mass.

Forgings, Steel
Baldwin Steel Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.

Forgings, Steel—*Continued.*
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash & Co., Geo., New York.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash & Co., Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott, J. M., Prov., R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash & Co., Geo., New York.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Rivet
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker - Brainerd Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Sons & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.

Gear Cutting Machinery—*Continued.*
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Rawhide
Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker - Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker - Wheeler Co., Ampere, N. J.
Dayton Machine & Tool Works, Dayton, O.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Norton & Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfied, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

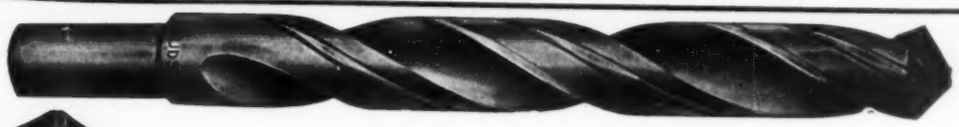
Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Iroquois Mach. Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Piston Ring
Heald Mach. Co., Worcester, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Modern Tool Co., Erie, Pa.



HUDSON HIGH POWER STEEL

Your shop isn't too small to profit by the use of Hudson High Power Tools.

Big cuts; cheaper production. Cheaper production; more business. Logical, isn't it?

Hudson steel requires less re-working than any other brand.

Hudson Twist Drills—all sizes in stock. Taper, Straight Shank and Jobbers' Length.

Baldwin Steel Co.

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How Many 6-Inch Belts Have You?

Do you Know you can Lace 500 of them Free of Charge by getting a

JACKSON BELT LACER?

And lace each belt in three minutes? And do it in such a way that the belts can be shortened or lengthened in a few seconds to meet any emergency? And that the lacing won't break? And that it passes over the smallest pulley without noise, slipping or friction? If you don't know these things, it's because you've missed five minutes' very pleasant reading of a little Booklet we send to interested parties. Better send for it to-day and learn about this free belt-lacing proposition.

Birdsboro Steel Foundry & Machine Co.,

Birdsboro, Pennsylvania.

UNITED STATES AGENCIES—John F. Orth, 199 Washington St., New York City J. E. Rhodes & Son, Philadelphia, Pa. Bailey Lebby Co., Charleston, S. C. E. A. Kinsey Co., Cincinnati, O. Strong, Carlisle & Hammond Co., Cleveland, O. Vonnegut Hardware Co., Indianapolis, Ind. Oliver Mfg. Co., 239 S. Despiaines St., Chicago, Ill. J. T. Wing & Co., Detroit, Mich. Henshaw, Bulkley & Co., San Francisco, Cal. Dominion Belting Co., Hamilton, Canada.

FOREIGN AGENCIES—Selig, Sonnenthal & Co., London, Eng. Wilh. Sonesson & Co., Malmo, Sweden. De Fries & Co., Dusseldorf, Germany. Jean Braun, Moscow, Russia. S. Lambercier & Co., Geneva, Switzerland. R. Stokvis & Zonen, Rotterdam, Holland. Hanel & Shember, Vienna, Austria. Theodore Koelliker, Milan, Italy.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co.,Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding and Polishing Machinery

Abrasive Material Co., Philadelphia, Pa.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Goodell - Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Prov., R. I.
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co.,Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Iroquois Mach Co., New York.
Lamb Electric Co., Grand Rapids, Mich.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Norton Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Royersford Foundry & Mach. Co., Royersford, Pa.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels

Adams Co., Dubuque, Iowa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Diamond Mach. Co., Prov., R. I.
Hampden Corundum Wheel Co., Brightwood, Mass.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.

Grinding Wheels—*Continued.*

Vitrified Wheel Co., Westfield, Mass.
Worcester Emery Wheel Co., Worcester, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames

Athol Machine Co., Athol, Mass.
Niles-Bement-Pond Co., New York.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery

Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Eng. Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Chisholm & Moore Mfg. Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power

Beaudry & Co., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Ct.

Hammers, Steam

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Eng. Co., Chambersburg, N. Y.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool

Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting

Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water

Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus

Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hoisting and Conveying Machinery

Alliance Machine Co., Alliance, O.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Cresson Co., Geo. V., Phila., Pa.
Eastern Machinery Co., New Haven, Conn.

Hoisting and Conveying Machinery—*Continued.*

Jeffrey Mfg. Co., Columbus, O.
Lamson Consolidated S. S. Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric

C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand

Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic

Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hose, Steel

Sprague Electric Co., New York.

Igniters, Gas Engine

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed

Niagara Tachometer & Inst. Co., Niagara Falls, N. Y.
Starrett Co., L. S., Athol, Mass.

Indicators, Speed, Peripheral

Warner Instrument Co., Beloit, Wis.

Indicators, Test

Norton Co., Worcester, Mass.

Industrial Railways

Hunt Co., C. W., West New Brighton, N. Y.

Injectors

International Specialty Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Inspection and Tests

Hunt Co., Robert W., Chicago, Ill.

Instruction Schools

See Schools, Correspondence.

Instruments, Electric

General Electric Co., New York.

Jacks, Hydraulic

Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Watson-Stillman Co., New York.

Jacks, Planer

Armstrong Bros. Tool Co., Chicago, Ill.

Kettles, Soda

Brown & Sharpe Mfg. Co., Providence, R. I.
Mfg. Equip. & Eng. Co., E. Boston, Mass.

Key Seaters

Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Chattanooga Machinery Co., Chattanooga, Tenn.
Davis Mach. Co., W. P., Rochester, N. Y.
Marshall & Huschart Machry. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.

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Whitney Mfg. Co., Hartford, Ct.

Keys, Machine

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Knurls

Hammacher, Schlemmer & Co., New York.

Lamps, Arc

General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lamps, Incandescent

General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
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American Tool Wks. Co., Cin., O.
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Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs

Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
LeCount, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.

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Barnes Co., W. F. & John, Rockford, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Diamond Mach. Co., Prov., R. I.
Dreses Mach. Tool Co., Cin., O.
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Fay & Scott, Dexter, Maine.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
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LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Motch & Merryweather Machinery Co., Cleveland, O.
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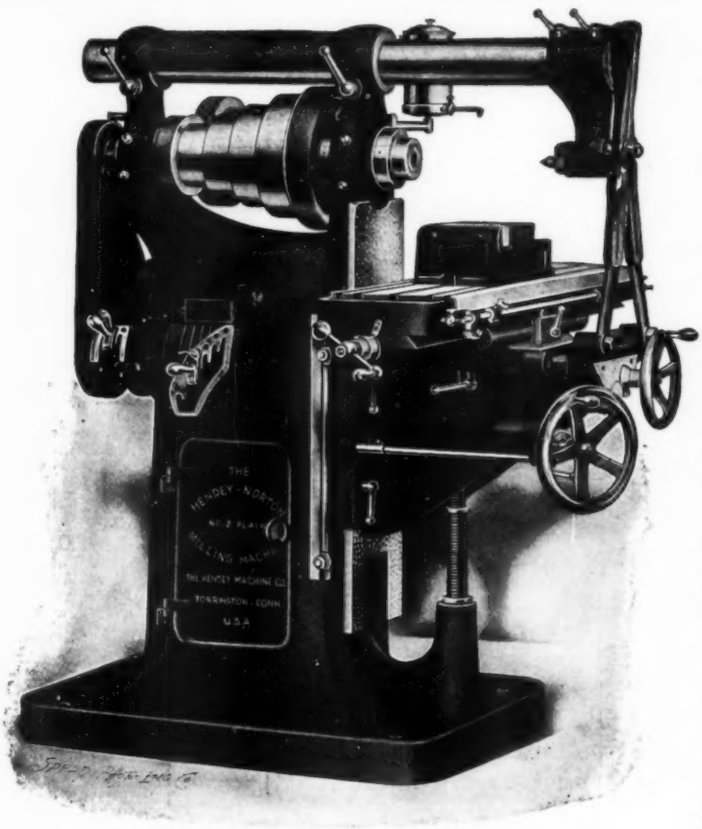

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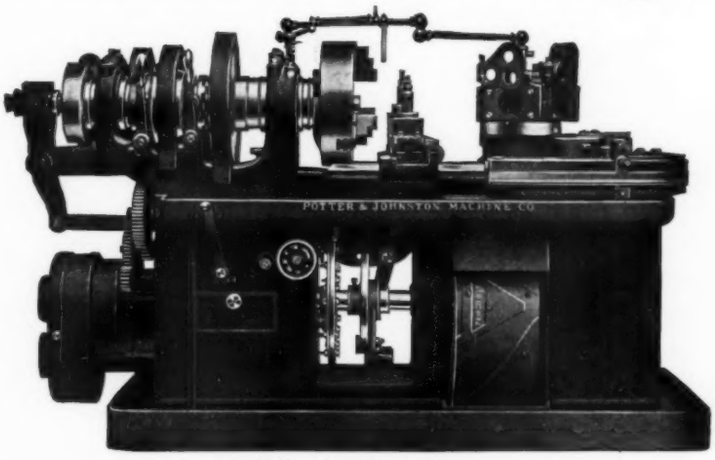

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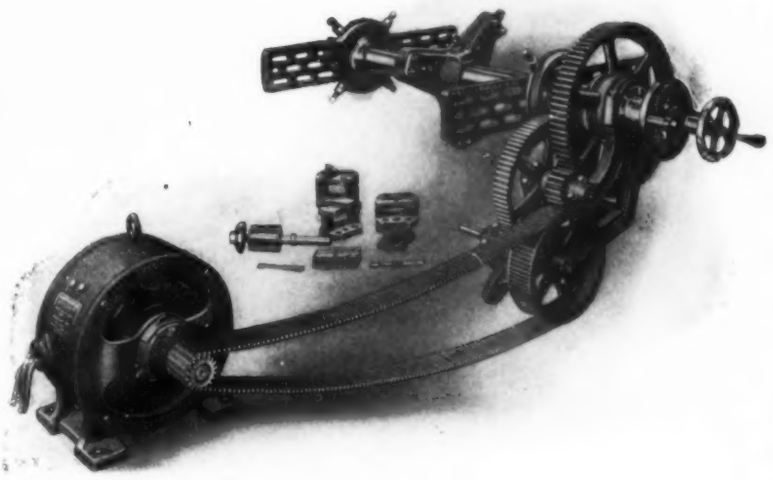

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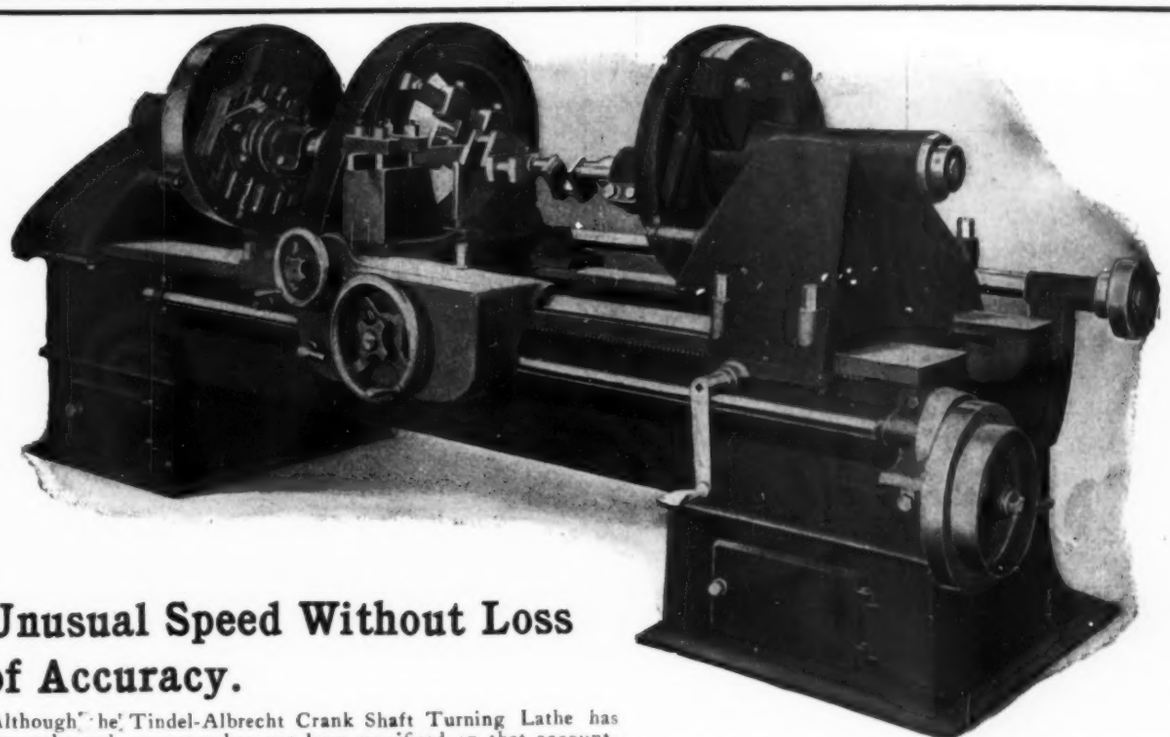

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Parker & Co., Chas., Meriden, Ct.
Reed Mfg. Co., Erie, Pa.

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Curtis & Curtis Co., Bridgeport, Conn.
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Saunders Sons, D., Yonkers, N. Y.

Vises, Planer and Shaper
American Tool Wks. Co., Cin., O.
Cincinnati Planer Co., Cin., O.
Hendey Mach. Co., Torrington, Ct.
Niles-Bement-Pond Co., New York.

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Graham Mfg. Co., Prov., R. I.

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Parker & Co., Chas., Meriden, Ct.
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Wyman & Gordon Co., Worcester, Mass.

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Pratt & Whitney Co., Hartford, Conn.
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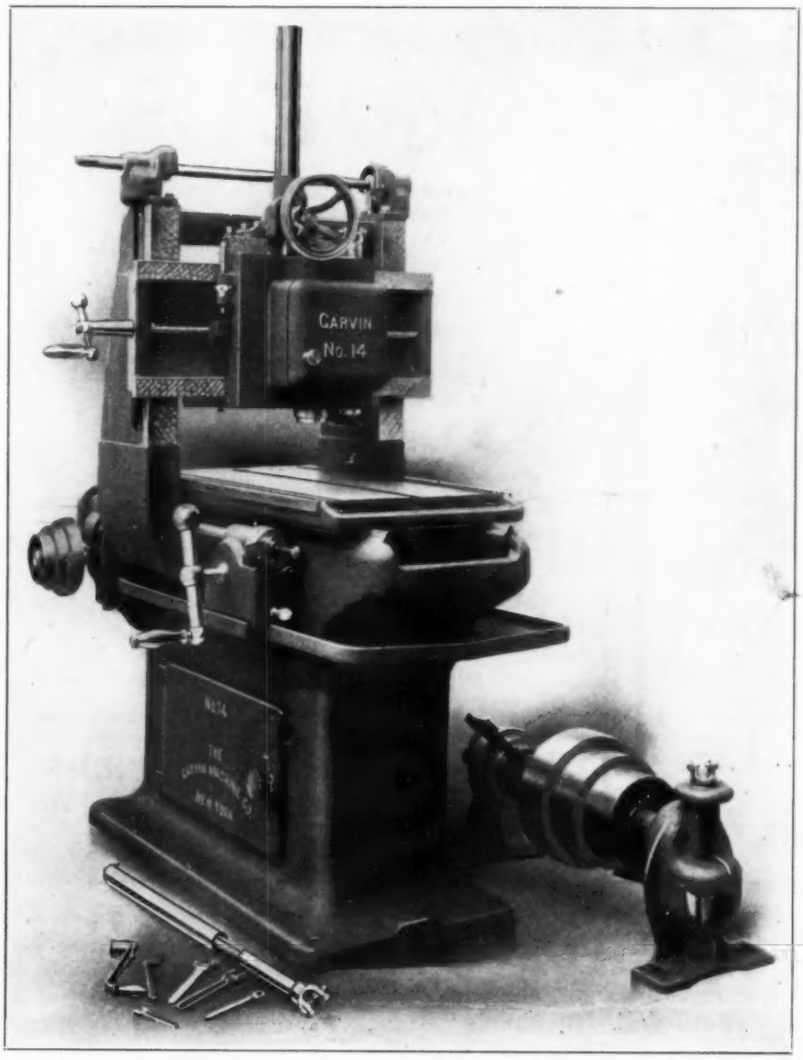
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Wrenches, Pipe
Whitman & Barnes Mfg. Co., Chicago, Ill.



Garvin Vertical Spindle Milling Machines.

The Vertical Spindle Milling Machine herewith presented offers special facilities for machining gear and engine casings of automobiles, railway-car motor casings, box castings and frames of special machines, and all such similar work requiring the finishing of different surface joints and edges to varying gauge levels and widths, and permitting the cutter to be moved all around the outside of the casting and dropped down inside with rapidity and ease, and absolute precision of movement.

The spindle slide is mounted on an adjustable cross rail to accommodate widely varying heights of work, but the spindle slide itself has a quick vertical movement of sufficient range to handle any ordinary piece of work without having to change the position of the rail. The spindle is balanced, and the vertical movement is by quick pitch screw and large hand wheel, giving 1" per turn, and limited by an adjustable micrometer stop screw fitted with binder, and special provision for using gauge blocks between the end of the stop screw and the fixed stop.

The spindle is moved across the face of the table by screw fitted with micrometer dial, and provided with adjustable stops each way. On the larger No. 15 machine, power feed with reverse and automatic trip is provided for cross feed. A special square stop and trip rod is provided for the cross feed on the larger machine, which may be notched on one side to suit certain positions of the cross slide for one job, and another side of the stop bar can be notched to suit another piece of work; these stop notches, when once made, being instantly available thereafter without resetting.

The rail is raised and lowered by a crank on the shaft running along the top of the upright, and can be clamped to the upright at any height.

The spindles are forged crucible steel, with taper main bearing running in solid self-oiling bronze boxes.

A draw-in rod is provided for arbors, the No. 14 has a No. 10 B. & S. taper hole and the No. 15 has a No. 11 B. & S. taper hole with clutch end driver and threaded nose to take B. & S. No. 24 Cutter.

Power is transmitted to the spindle direct from the countershaft by a telescoping shaft which permits freedom of movement in all directions with a minimum of shafts and gearing. The spindle is geared to a pinion shaft carried on the spindle slide, and is geared up with sufficient power to drive a 9" cutter on the large machine, and a 6" cutter on the smaller size.

Two ratios of gearing are provided on the large machine, and the telescope driving shaft is connected to the pinion shaft for slow speeds, and for high speeds the universal joint shaft can be connected direct to the spindle; the gearing being moved out of mesh.

On the smaller machine, two gear changes, slow and fast, are provided. The spindle gearing is entirely enclosed, and on the smaller machine, changes of gear speed, are made by opening the cover door and sliding a gear on the spindle.

On the larger machine changes of back gear are made by sliding the pinion shaft up and down, which is done by making one turn of a lock pin handle, on the right of the spindle slide. Half a turn of the handle throws out both sets of gears, when the spindle is to be driven direct for high speeds, and the plunger pin holds the handle in the position it is set. In addition to the changes of speed by gearing, a three speed friction cone pulley on the countershaft is provided.

The feed is driven from the countershaft through three step cones and change gears.

The tables are large with numerous T-slots; the table of the large machine being driven by the Sellers Motion of oblique worm, ball thrusted, and the smaller machine is fed by spur gearing with adjustment for taking up all back lash.

The feed mechanism is driven through worm gear, running in oil bath and fitted with reverse and automatic trip.

Control of all movements, changing of speeds and feeds, starting, stopping and reversing, setting of stops, binders, etc., are all within reach of the operator standing at the side of the machine.

All gearing is protected and a large oil pan and oil reservoir in the base is provided, to which pump and piping can be attached when desired. The countershaft is compact and drives the machine through heavy bevel gears, one of which is raw hide.

Motor drive can be applied to these machines in a very simple and convenient manner; the motor being mounted on the rear end of the upright.

Dimensions	No. 14	No. 15
Size of table	20x36 in.	25x48 in.
Maximum clearance under rail	12 in.	15 in.
Minimum clearance under rail	4 in.	5¾ in.
Minimum distance—end of spindle to table	1 in.	1 in.
Length of power feed	36 in.	48 in.
Distance between uprights	26 in.	34 in.
Traverse of cross slide	26 in.	29 in.
Change of speed	6 in.	9 in.
Width of belt	3½ in.	4 in.
Front spindle bearing	2⅝x3¼ in.	2¾x4¼ in.
Taper hole in spindle	No. 10 B. & S.	No. 11 B. & S.
Speed of countershaft, revolutions per minute	120 on large step of cone.	120 on large step of cone.
Floor space required	48x72 in.	61x96 in.
Domestic shipment, crated, weight	3000 lbs.	5790 lbs.
Foreign shipment, tight boxed (100 c. f.), weight	3850 lbs. (178 c. f.)	6600 lbs.
Code, as shown, with countershaft	Acerval	Adagio
Code of pan, pump and piping	Actinic	Adamic

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A stock of our machines is carried on hand at all times by the following agents: Hill, Clarke & Co., New York, Boston, Chicago and St. Louis; W. M. Pattison Supply Co., Cleveland; E. A. Kinsey Co., Cincinnati; J. W. Wright & Co., St. Louis. We are also represented by the Chas. G. Smith Co., Pittsburg; W. K. Shipley, Philadelphia; Cotton States Belting & Supply Co., Atlanta; Roy Machinery Co., Minneapolis; Baily-Smith Machinery Co., San Francisco.

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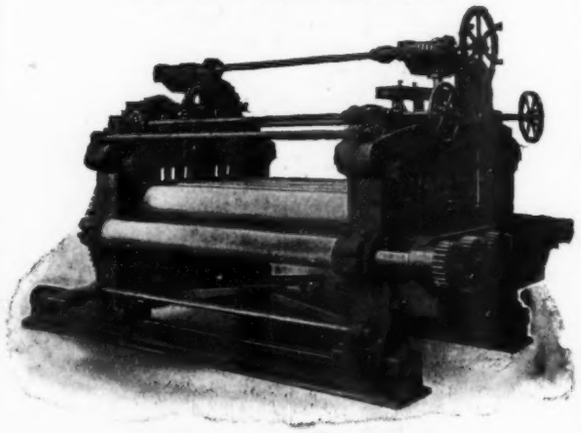

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A book which shows that Cams can give an unlimited variety of movements, and that better results can often be obtained with Cams at less expense and with less complicated and trappy construction than is otherwise possible is

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Consider the Compactness of the

HIGLEY SAW

This is a point fully as important as efficiency or simplicity. The Higley machines are the most compact tools of their class. Because of the little floor space required, they can be used where an arbor-driven machine would be out of the question.

Buckling is impossible in rapid cutting, for the blade is drawn through the metal, not forced from the center; a large center collar or plate is not needed to preserve the rigidity of Higley blades; in short, saws that are guaranteed to turn out all cold sawing propositions in the shortest time and at the least expense.

The Higley is well worth looking up. The Catalog will post you fully. Shall we send it?

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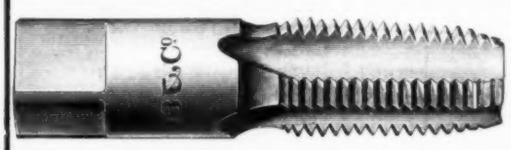

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are those stamped "Butterfield & Co." This is not a mere "puff," but an actual fact, demonstrated every working day of the year in any number of shops "Butterfield & Co." make Derby, Reece, and other screw plates, reamers, and the like.

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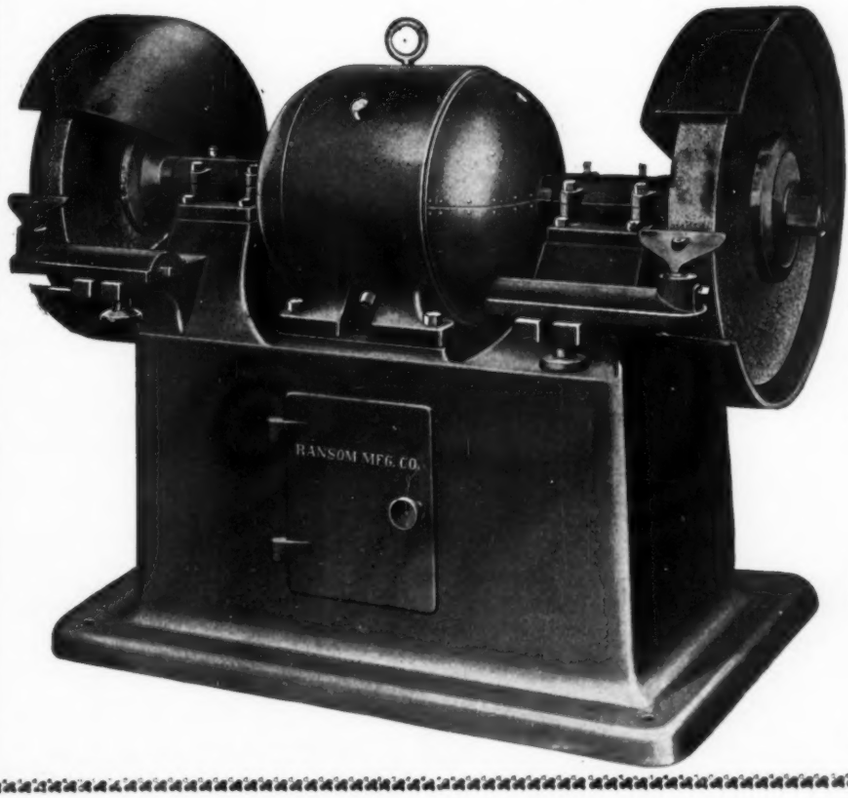

THE armature of the motor is wound on a sleeve, which is pressed on to the arbor. This will be found the best construction when repairs become necessary.

The motor has more commutator bars than other makes.

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that we have altogether too many Tools—our sole aim now is to get the room, so previous low prices will be liberally discounted. Chief among them are Planers and Lathes, and not a "back number" in the lot:

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86 in. x 18 ft. Tr-geared, Screw, Compound-rest, Cross-feed, Spindle 12 in. Wt. 30,000 lbs.
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15 in. Friction-grd., "Hendey."
20 in. Crank, Double Triple Stroke, "Gould & Eberhardt."
18 in. Friction-grd., "Prentiss."

MILLING MACHINES.

22 in. x 5 ft. Heavy Plain "Ingersoll," Wt. 10,000 lbs.
No. 18 Tool room Universal, "Brainard."
"Brainard," "Garvin," "Pratt & Whitney," Plain.

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2¼ in. Wire feed Hub Machine, "Pratt & Whitney."
16 in. x 4½ ft. Monitor Lathes, "Warner & Swasey."
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Alligator Shears, Cap'y 6 in. x 1 in.

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48 in. x 24 ft. Triple Geared.
42 in. x 16 ft. " "
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18 in. x 8 ft. } Boye."
18 in., 15 in., 16 in. and 18 in. x 6 and 8 ft. beds, "Qk-change."

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16 in. " " "
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"Latest" vertical fd. and new features.

RADIAL DRILLS 60, 84 and 96 in. swing, "Latest," positive feeds, tapping attachments.

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1—2" Cleveland Automatic Screw Machine
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16 x 6 C. R. & T., Fitchburg
18 x 8 C. R., Fitchburg
18 x 8 Plain, Flather
18 x 8 C. R., McMahon & Carver
18 x 8 Plain, Wright & Powell
18 x 10 Plain, Wright & Powell
18 x 12 Plain, Niles
20 x 12 R. F., Fitchburg
22 x 8 Plain, Miles
24 x 12 Swivel, Ames
24 x 14 C. R., Niles
24 x 12 Plain, L. W. Pond
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35 ft. Pit, Niles
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120 x 96 x 20 Niles, 4 heads, Motor-driven

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9 in. Traverse Head, Sellers
12 in. Traverse Head, Bement
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15 in. Friction, Hendey
18 in. Double Head, Cincinnati
18 in. Traverse Head, Fitchburg
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14 in. 4-Sp. Gang, Garvin
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24 in. Sliding Head, Wheeler
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4 ft. Semi-radial, Hilles & Jones
5 ft. Semi-radial, Barr
7 ft. 6 in. No. 5 Univ., Niles
2-Sp. Adjustable, Foote-Burt
3-Sp. Adjustable, Foote-Burt
6-Sp. Turret, Quint.

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Garvin Hand Miller
No. 1 Univ., LeBlond
No. 1 Univ., Garvin
No. 0 Plain
No. 3 Plain, LeBlond
Index Miller, Brainard
No. 0 Column, P. & W.
No. 2 Plain, Garvin

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Horizontal Boring Head
Horizontal Miller, Hoefer
96 in. x 10 ft. Cylinder, Stearns
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1½ in. 4-Spindle Acme Nut Tapper
2 in. Pipe Machine
Garvin Profiler
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Hand Screw Press
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5 h.p. 110 V. Motor, Con. Speed
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1— 9"x57" Barnes C. R. P. C. F.
1—10"x54" Davis R. & F.
3—11"x5' Barnes C. R. P. C. F.
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1—11"x6' Barnes C. R. P. C. F.
4—11"x4' Mann R. & F.
1—12"x5' Silk R. & F. and Taper
2—14"x5' Fay & Scott R. & F.
1—14""x6' Fay & Scott C. R. P. C. F.
1—18"x16' Fay & Scott C. R. P. C. F.
1—24"x12' Fay & Scott C. R. P. C. F.
1—28"x14' Fay & Scott C. R. P. C. F.
1—28"x16' Fay & Scott C. R. P. C. F.
1—29"—36"x12' Fifield C. R. P. C. F.
1—32"x26' Fay & Scott C. R. P. C. F.
1—34"x14' Porter C. R. P. C. F.
1—42"x20' Fay & Scott C. R. P. C. F.
1—72"x15' Pittsburg C. R. P. C. F.
1—90" Ridgway Driving Wheel
1—No. 4 Windsor Plain Monitor
1—No. 3 Windsor Fric. Hd. Monitor
1—16"—32"x 8' Fay & Scott Gap
1—32"—56"x12' Fay & Scott Gap
1—42"—70"x12' Fay & Scott Gap

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1—24"x24"x 6' Pond
1—24"x24"x 6' Chandler
1—24"x24"x 8' Chandler
1—24"x24"x10' Chandler
1—30"x30"x 8' Cincinnati
1—36"x36"x12' Chandler, 2 Heads

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3—No. 2 Burke Hand
1—No. 3 Burke Hand
2—No. 2 Fox Hand
1—No. 2 Fay & Scott Vertical

SHAPERS

1—14" Gould & Eberhardt Crank
1—25" Steptoe Crank B. G.
1—26" Juengst Friction

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4—42" Rogers, 2 Heads
1—44" Rogers, 2 Heads
1—48" Colburn, 2 swivel heads, plain table
1—48" Colburn, 1 swivel head, 1 swivel turret head, 3 jaw chuck power rapid traverse for both heads
1—7' Poole, 2 Heads

PRESSES

2—No. 1 V. & O. Power
2—No. 1 Hibbard Power
1—No. 2 Hibbard Power
1—No. 2 Greenerd Arbor
4—No. 3 Greenerd Arbor
2—No. 3½ Greenerd Arbor

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12—20" Davis complete
1—20" Barnes W. & L.
6—20" Barnes complete
2—21" Cincinnati complete, with tapping attachment
2—21" Cincinnati W. & L.
1—26" Barnes Staty. Hd., complete
1—31" Barnes Slid. Hd., complete
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1—8-spindle Gardam Adjustable Spindle; also one, two and three-spindle sensitives

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1— 25 lb. Scranton Power
2—350 lb. Bell Steam
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1—No. 3 Merriman Bolt Cutter
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2—10 B. Besly Disc Grinders
64x20x1¼ P. Gould & Eberhardt Gear Cut.

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50 lb. Belt Post, Dieneit & E.
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16"x6' W. & S. Grd. Fox Turret.
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12"x4' American Lathe, 2 motion to sp.
No. 1 2-spindle Valve Miller, W. & S.
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24"x24"x5' Powell, single head.
48" Betts, widened to 72"x20'.
Sellers Plate, 24x14'.
Niles Boiler Plate, open ends, 16 ft.

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Air Hoist, 6¼x2' 6" stroke.
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No. 9 Boyer Long Stroke Rivet Hammer.
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Keyseater, Burton Hor.
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2"x24" Geared head
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12—Assorted turret lathes

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16"x10" Special surface grinder
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No. 4 Garvin plain
No. 12 Brown & Sharpe, plain
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60 Lathe for fly-wheels
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60" Niles Pulley Boring Machine
60" Niles Pulley Lathe
36" Niles Pulley Lathe

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22x22x5 New Haven Planer, one head
24x24x6 Putnam, one head
31x31x6 Kirkwood, one head
37½x37½x12' Hewes-Phillips, one head
47x41x12' New Haven, one head
48x36x12' Sellers, one head
52x48x15' Sellers, two heads
57x57x17' Sellers, two heads

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1" Double Head Bolt Cutter
100 lb. American post hammer
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1" Spencer Automatic screw machine
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25" Riveter, gap

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(1) No. 4 Cincinnati Plain (old style)

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(1) 16" Crank Planer
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(1) 24" Hendy Shaper
(1) Gisholt Universal Tool Grinder
(1) National Surface Grinder
(1) 2" Pratt & Whitney Cutting-off Machine
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(1) 18" Dill Slotter
(1) 26" Niles Vertical Chucking Machine
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18"x 6',	Bradford,	- -	Plain Rest
18"x 8',	Hamilton,	- -	Compound Rest
28"x14',	Fifield,	- - -	Compound Rest
32"x12',	Gleason,	- -	Compound Rest
36"x12',	Blaisdell,	- -	Compound Rest
36"x14',	Fifield,	- - -	Compound Rest

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26"x26"x 8',	Wheeler,	- -	One Head
27"x27"x 8',	Ames,	- - -	One Head
27"x27"x 8',	Powell,	- - -	Two Heads
36"x36"x10',	Putnam,	- -	One Head
36"x36"x14',	Whitcomb,	- -	One Head
38"x38"x12',	Pond,	- - -	Two Heads

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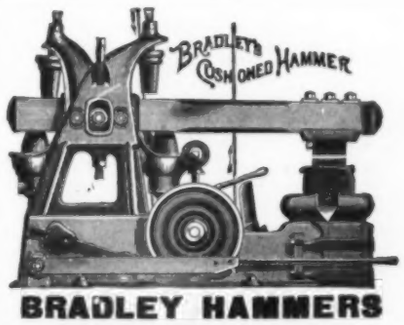

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A greater number sold each year than of all other power hammers combined.

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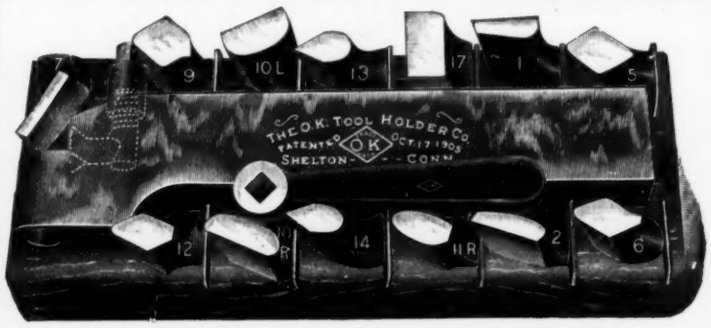

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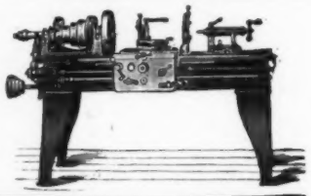

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Four Sizes
25 in. and 39 in.
28 " " 48 "
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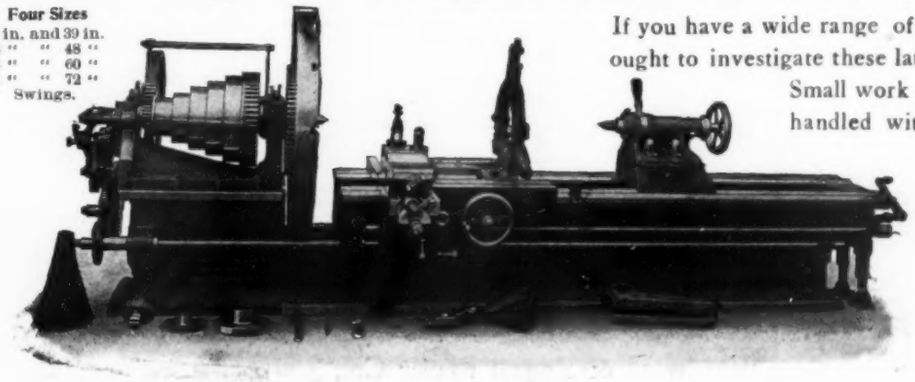
Swings.



If you have a wide range of work to turn out, you ought to investigate these lathes.

Small work or large work can be handled with more profit, as the gap can be adjusted to suit the nature of the work. We're hoping to hear from *you* on the subject. At least, let us send you the Catalog.

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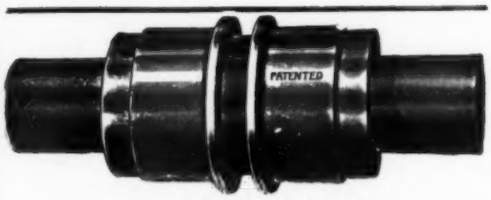

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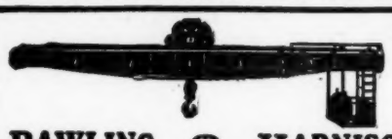

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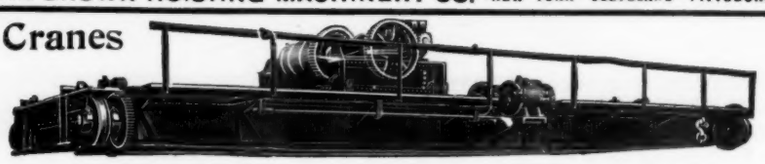
Cranes



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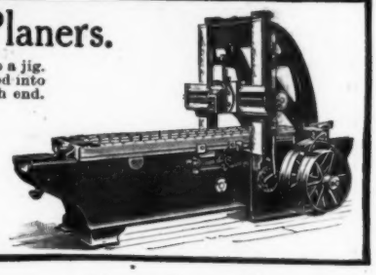

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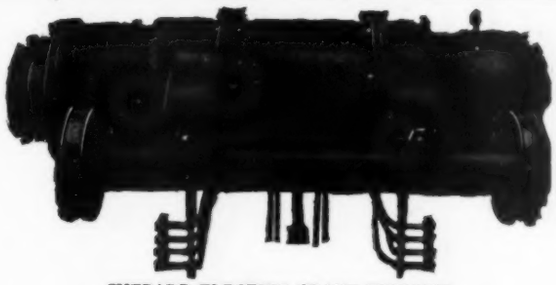

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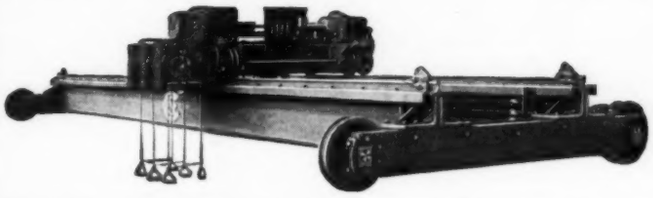

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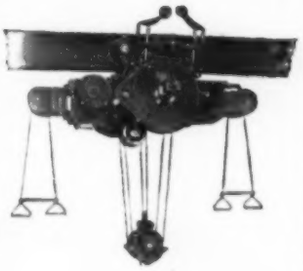

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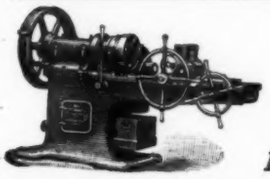

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Single and Multiple Spindle Drills

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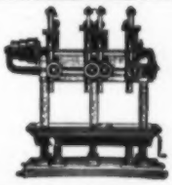

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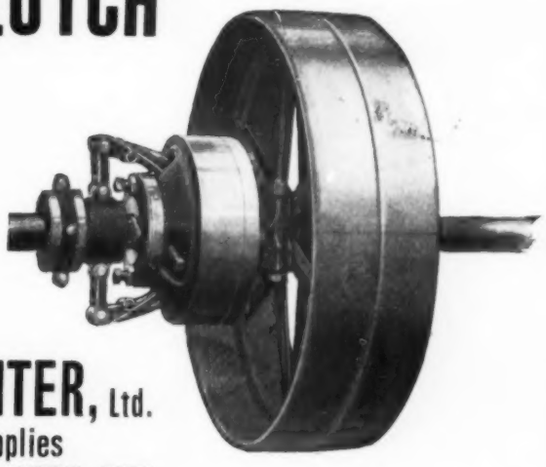

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Universal Benders for Angles and Other Shapes.

Rotary Shears, Gap Riveters, Punch and Shear.
Write for Catalogue.

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Rowbottom Machine Co.
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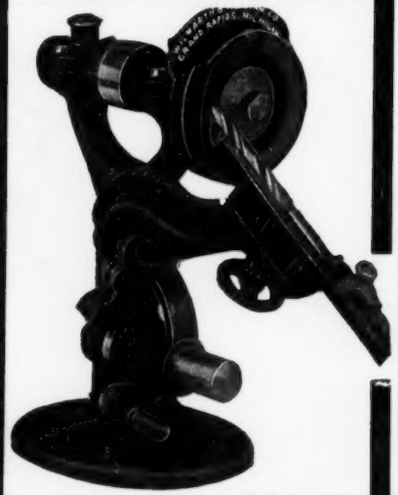
F. N. Gardner's Improved Disc Grinders.

Designed and built by F.N.Gardner, well known as the inventor and originator of Disc Grinders. Send for Catalogue and record of "Actual Tests."

Gardner Machine Co., Beloit, Wis.
The Disc Grinding Authorities.



Have You Our CATALOG?
If not you SHOULD have it, and you CAN have it for the asking. It will acquaint you with the

NEW YANKEE DRILL GRINDER

Wilmarth & Morman Co.,
887 Canal Street, Grand Rapids, Mich.

Try This Grinder At Our Expense.

That's the way to know its true worth. Just the Grinder you've wanted for grinding centers, milling cutters, spiral mills, etc.
When writing, be sure to ask about our Portable Electrical Drill.

The Cincinnati Electrical Tool Company,
CINCINNATI, OHIO.
New York Office, 95 Liberty Street.

"ECONOMO" Emery Wheel Dressers.

LENGTH — 12 INCHES.

Shorter lengths on application.

Made of an abrasive nearly as hard as the black diamond. Will true and shape any wheels except the very hard and carborundum.

The "Combination" Dresser is the roughing dresser placed in the "handle end" of the Economo. The cutters are made of "Crucible" steel and excel in wear and efficiency any dresser heretofore made. Send for circular. Sent on fifteen days' trial.

"COMBINATION"

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"ABRASIVE" EMERY WHEELS

Don't merely grind—they "cut"—cut fast and are durable. Catalog.

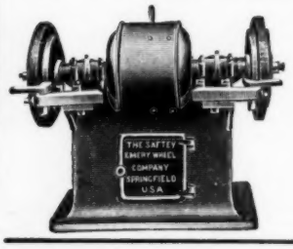
Abrasive Material Co., Phila., Pa.

95% Pure

corundum is used in our grinding wheels. That's one reason for their superiority. The others are in the catalog.

The Vitrified Wheel Co.,
Westfield, Mass.

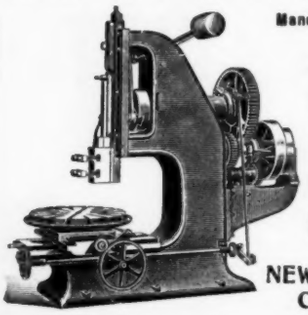
No. 21 CHAMPION MOTOR DRIVEN GRINDER.



For wheels 24" diameter. Size of motor, 7½ H. P.
Weight, 1800 lbs. Height floor to center of spindle, 32".
Length ring oiler bearings, each 12".
Diameter spindle in bearings, 2¼".
Diameter spindle between flanges, 2".
Diameter of flanges, 8". Distance between wheels, 43".
Entire length of spindle, 43½" x 27".
Machine is equipped with controller arranged for three speeds, 900, 1050 and 1200 revolutions.

SAFETY EMERY WHEEL COMPANY
SPRINGFIELD, OHIO

NEW HAVEN MFG. CO.,
Manufacturers of



Slotters,
Planers,
Lathes,
Drills,
Etc.

NEW HAVEN, CONN.

Worcester Corundum Wheels

lead the corundum-wheel procession, because of their superiority of workmanship, excellence of raw materials, character of composition and method of manufacture. Will you talk the subject over with us?

Send for the printed matter anyway.

Worcester Emery Wheel Co.,
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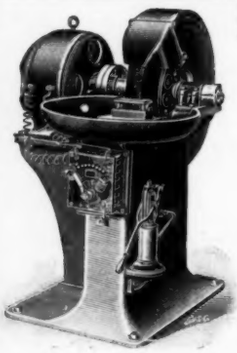

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IN THE
Bridgeport Motor-Driven Tool Grinder.

It gives you the right speed, regulated to increase as wheel wears and remain constant.

Bearings are finest ever put on grinders.

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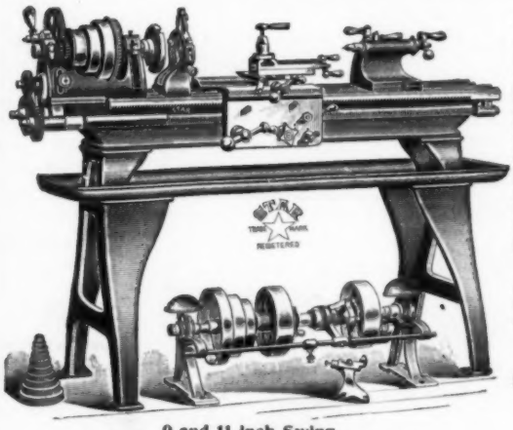
The Bridgeport Safety Emery Wheel Co.
(Incorporated)
Bridgeport, Connecticut.

Accurate Lathes of Small Dimensions



"STAR" LATHES are designed, after years of experience, to be thoroughly accurate and reliable lathes of small dimensions, something better than any other small lathes, ever before offered at low prices. They will do much of the work now put on larger lathes, occupy less space, cost less and do more work for every dollar you have invested. That is why you should use "STAR" LATHES.

They are used by hundreds of the best mechanics throughout the United States and foreign countries.

Send for Catalog "B" giving full descriptions.

9 and 11 inch Swing
24, 36, 48 and 60 inches between centers

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(109A)

No. 58 Hand Machine. Range 2⅛—6 in. R. H.

WITH A **Forbes Patent** DIE STOCK ONE MAN can with ease cut off and thread a 12 inch pipe.

Smaller Sizes Proportionately Easy.
Catalog on application.

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The Two Part Pin Construction of

THE MORSE

Silent Running High Speed Chain

permits an unbroken contact the whole width of the chain, thus doubling the length of bearing surface in a chain of given width. In other chains built up of alternate links, one set of links must carry the pressure of the pin in each direction, leaving but one-half the length of the pin or bearing surface.

Our Catalog No. 7
Gives further interesting particulars.
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are the oldest on the market and the best that man can produce. Ask your dealer for them.

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a Paxson-Warren Sand-Blast Machine will enable you to get at places otherwise inaccessible. It cleans everything cleanable by the sand-blast process and cleans it thoroughly. It is well made and simple.

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You Can't Go Wrong In Buying The Frisbie Friction Clutch.

Its record supports every claim we can make. This clutch is never anything but first grade. Remember, that the clutches that are lower in first cost have *only that* to recommend them.

Whether you've ever considered the friction clutch proposition or not, we would like a chance to prove that the Frisbie Friction Clutch is superior. Write us about it and let us send our catalog.

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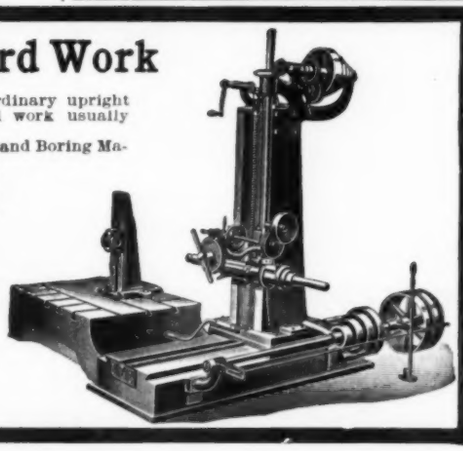
Handles Awkward Work

that cannot be handled on the ordinary upright or radial drill in addition to all work usually handled on a drill.

On the Hoefer Horizontal Drilling and Boring Machine, with table, the work is always in alignment and many operations can be finished with one setting of the work. Ask for catalog.



Hoefer Mfg. Co.
250 Liberty Street,
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Our Small Lathes

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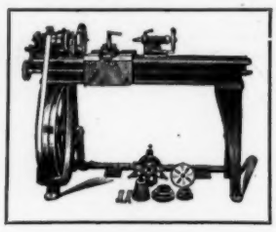

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For screw cutting are winners. They please in both quality and price. Two sizes—9 inch and 11 inch—in either foot power or countershaft style. Equipped with many advantageous features, all described in our latest catalog, ask for it.

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EXCLUSIVELY
Horizontal Spindle, Vertical Spindle or Fourhead Machines
ALL SIZES.

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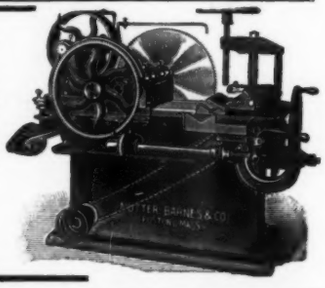
Metal Saw Cutting-Off Machine.
Cuts Stock Any Size or Shape.

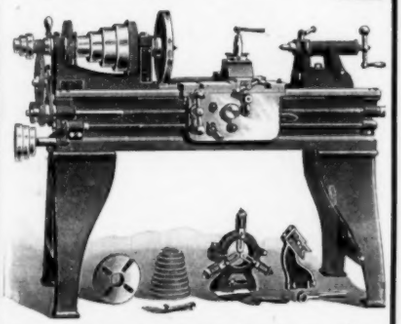
Cuts it economically too. Several small pieces can be clamped in "V" shoe at one time.
Fitted with thin saws—that means no waste. Saw has quick power return; central spur gear drive; positive gear—feed drive.

Catalog No. 10 for particulars.



Nutter, Barnes & Co., 366 Atlantic Ave. Boston, Mass.

Big Range--Fast Work



The Sebastian 15-Inch Lathe

is a good investment principally for three reasons. It gets out a large amount of work in minimum time; it handles the work usually put on a larger lathe; its first cost is low. That's about enough—but there are other reasons. Get our catalog and read them.

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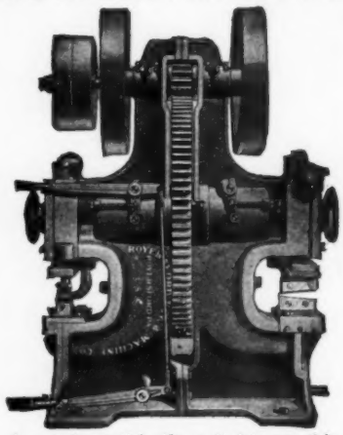
No. 3-A Double Punch and Shear



A good, well built, reliable machine with a 10″ throat. Has structural removable jaw on punch side, making it very convenient for punching "I" Beams and Channels. Will shear 6x¾″ flat and 1½″ o iron. Will punch 1″ through ¾″ iron.

Ask for Catalog.

Royersford Foundry & Machine Co.,
Royersford, Pa.

Goodell-Pratt Company
GREENFIELD, MASS. U.S.A.
HACK SAWS
FAMOUS FOR TEMPER AND CUT
HAND AND MACHINE BLADES OF ALL STANDARD LENGTHS AND WEIGHTS
Catalogue Free

OUTSIDE

A kid-like surface that clings to the pulley and transmits a **third** more power than **any** oak-tanned leather belt.

INSIDE

The long, strong rawhide fibres that mean longer life and shorter belting bills by the year—that's Sable belting.

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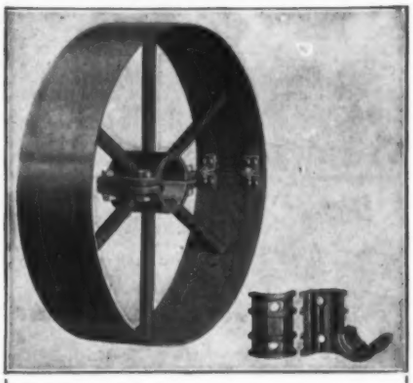

The Two Sections Of The Latshaw Steel Split Pulley

make one pulley that will endure highest speeds, with absolute safety. It is the strongest, most convenient, best steel pulley ever made.

Catalog ?

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[Large stocks carried by Brown Wales Co., Boston; Henry J. McCoy Co., New York; R. R. Street & Co., Chicago.

You Can Clamp Quickly With Bay State "Lightning" Clamps

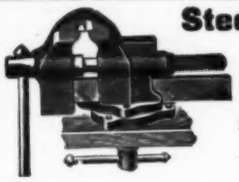
They are quickly adjusted by releasing body nut from screw. They are double-ribbed and never lose alignment. Get circular of convincing talk.

Tudor Manufacturing Company,
Makers of Bay State Tools. WORCESTER, MASS.

VICTOR HACK SAW BLADES

Stand on their Merits. We Protect the Dealer.

Massachusetts Saw Works, Chicopee, Mass.



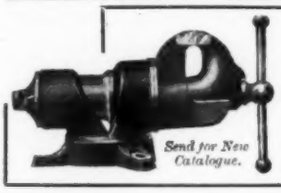
Steel Bar Vise

Parallel Jaws. Swivel Base.

Manufactured by

Merrill Bros.,
Kent Ave., Cor. So. 11th St.
BROOKLYN, N. Y.

Try one of these for better vise results.



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695 POUNDS

of solid mechanical muscle and brain constitutes

The "Pittsburgh" Railroad Vise

capable of turning in any direction. *Opens 16 inches.* Guaranteed.

The Pittsburgh Automatic Vise & Tool Co.
Pittsburgh, Pa.

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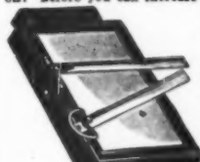
Are you improving in your drawing, or are you falling off? Before you can increase your salary you must increase your efficiency. The



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will help you to be a better draughtsman, because its use insures accuracy. It doesn't cost much.

Write for circular telling all about it.

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For sale by Charles Churchill & Co., Ltd., London, Eng.

For light and heavy work

the Reed Patent Swivel Vise is suitable. You need it in *your* tool room. Send for the printed matter about it.

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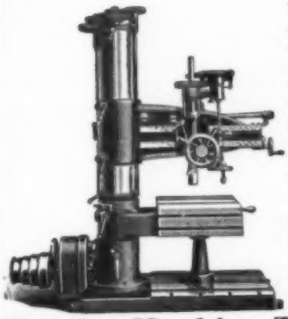
It Can't Wear Out, Doing Nothing



When the spindle of our New Patented Radial Drill isn't busy, the lower driving shaft is the only thing that moves. That's only one of the features that will please drill users. It's just out, so send for circular and see how good it is.

Mueller Machine Tool Co.,
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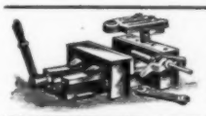
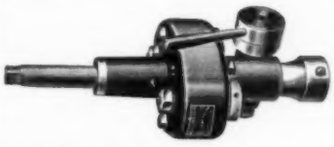


Graham Jig Vise

Always an ordinary vise and at the same time holds work for duplicate drilling without the cost of a jig.

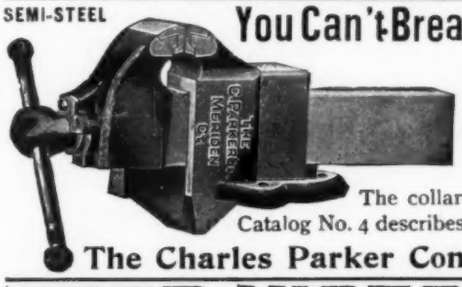


Drill Speeder. Sensitive feed lever. Safety frictions. Gives small drills their proper speed in large drills. Speeds up 4 to 1.

THE GRAHAM MFG. CO., Providence, R. I.

SEMI-STEEL

You Can't Break the Bar in Parker's Vise



Under the most severe working conditions. It's made of the best material and is **solid.** It isn't cored out and weakened to make room for the collar, as are those on ordinary vises. The collar is on the outside, held by one screw. Catalog No. 4 describes our entire line. Sent on request.

The Charles Parker Company, 32 Warren Street, New York. Factory, Meriden, Conn.

REED VISES are built to stand rough shop usage, and have wearing qualities that are unequaled. Get catalog "K" for details.

REED MANUFACTURING COMPANY, Erie, Penna., U.S.A.

BOLT HUNTING CONSUMES VALUABLE TIME.

Why not *save* all of this wasted time by adopting the use of *Lang's T Bolt Heads* with *Studs?* Studs are made easier than bolts, for odd lengths a boy at the bolt cutter can thread up the studs while the work is being leveled on the machine. The *descriptive circular* is ready for you.

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makes accuracy a "sure thing" on pay roll and cost records—cannot be otherwise. Want the details?

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Shapers, Drilling Machines, Bolt Cutting and Nut Tapping Machines and Machinists' and Blacksmiths' Forges.

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Blanking, Forming, Drawing, Cutting and Drop Forge. Stamping and Press Work of every description. Jigs, Tools and Fixtures. Experimental Work. Special Machinery designed and built to order. Submit Drawings or Samples for Estimate.

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Automatic Machines

for making Stove Bolts, Tire Bolts, Rivets, Lag Screws and Wood Screws.

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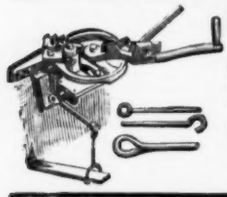
NO RUST

with Elliott Non-corrosive Soldering Fluid. Dealers, or direct.

Elliott Chemical Works, Newton, Mass.



EYE BENDERS.

We make hand power benders for forming eyes from stock 1⅜ inch thick and under. Any size eye 7 inches outside diameter and under.

Wallace Supply Co.,
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CHICAGO, ILL.

BALL BEARINGS

Plain Bearings, .5%
Friction, 0.2%

Auburn Ball Bearing Co.
18 COMMERCIAL STREET, ROCHESTER, N.Y., U.S.A.

Hess-Bright Ball Bearings

are fully guaranteed. They will carry the loads for which they are sold without breakage or appreciable wear. They reduce friction on line shaft to a surprising extent.

The Hess-Bright Mfg. Co.,
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Adjustable Reamers.

STYLE B.

The construction of this Reamer is such that it is necessary to grind only when dull. There is no uneven clamping with screws, nuts, or any other device. Adjustment made quickly and accurately.

Send for 1906 Catalog.

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Want To Catch Up With Your Machine Orders?

Haven't you some machine orders that you would like finished up NOW? Why not turn them over to us, and we are prepared to build IMMEDIATELY any of your machines or parts on contract. We've the facilities and the experience for doing such work and building all kinds of special machinery. As soon as the blue prints or patterns reach us, we'll commence work. Write today and let us know YOUR needs.

WADE MACHINE COMPANY, 133 Oliver Street, **Boston, Mass.**

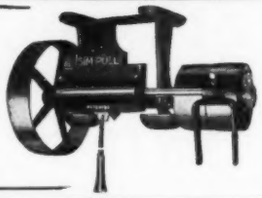
SHIFT YOUR BELTS BY A PULL

The Sim-Pull Counter Shaft

is operated by a pull on the handle. It starts and stops your machines with no loss of time or labor. No levers and wheels. It can't stop half-way. You are working at a loss without it.

Catalog No. 8.

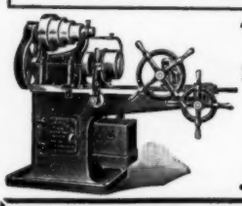
MOSSBERG WRENCH COMPANY
CENTRAL FALLS RHODE ISLAND



TURRET LATHE WORK WANTED.

We have a little surplus capacity in 21" Gisholt turret lathes and can take in some outside work for them. We will figure on machine work only—or will furnish castings also.

The Stoever Fdy. & Mfg. Co., Myerstown, Pa.



PIPE THREADING MACHINERY.

Pipe Cutting-Off Machines. Hand Stocks and Dies.
Pipe Couplings for Gas Lines.

STANDARD ENGINEERING WORKS,
ELLWOOD CITY, PA., U. S. A.
1012 Chemical Building, St. Louis, Mo.

DROP PRESSES For All Purposes Our Specialty.

MINER & PECK MFG. CO., Proprietors of
THE PECK DROP PRESS WORKS, - NEW HAVEN, CONN

Extra Heavy Rough Brass Unions

And BRASS CASTINGS For All Purposes.

Phosphor Bronze for Machine Box Bearings, Etc.
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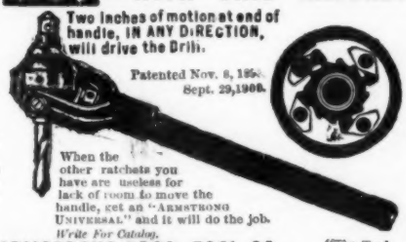

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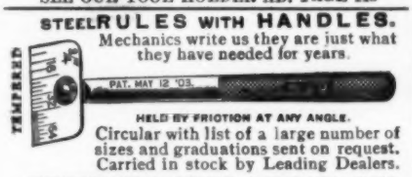

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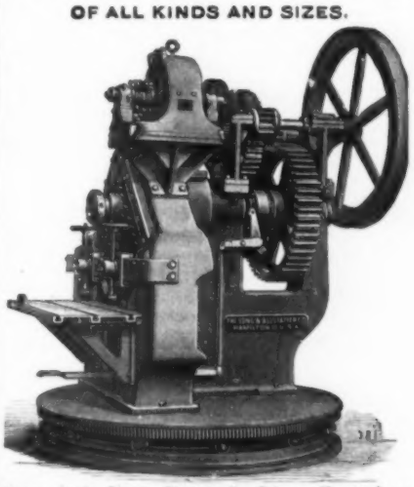

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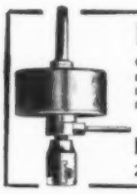

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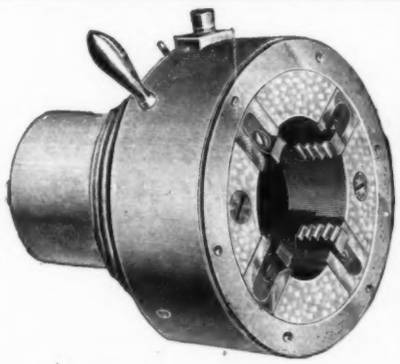

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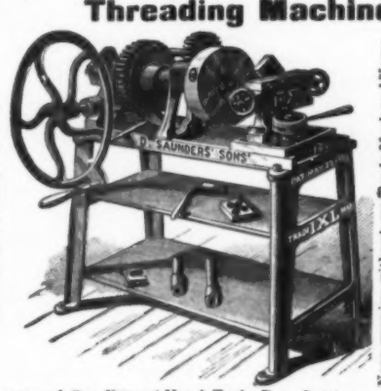

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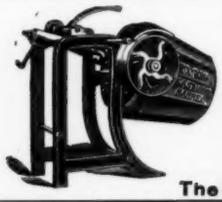

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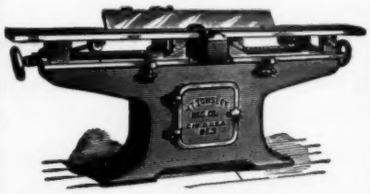

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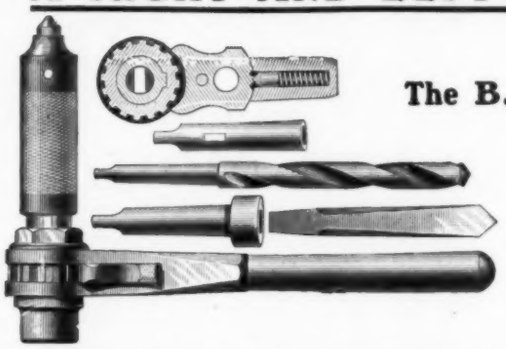

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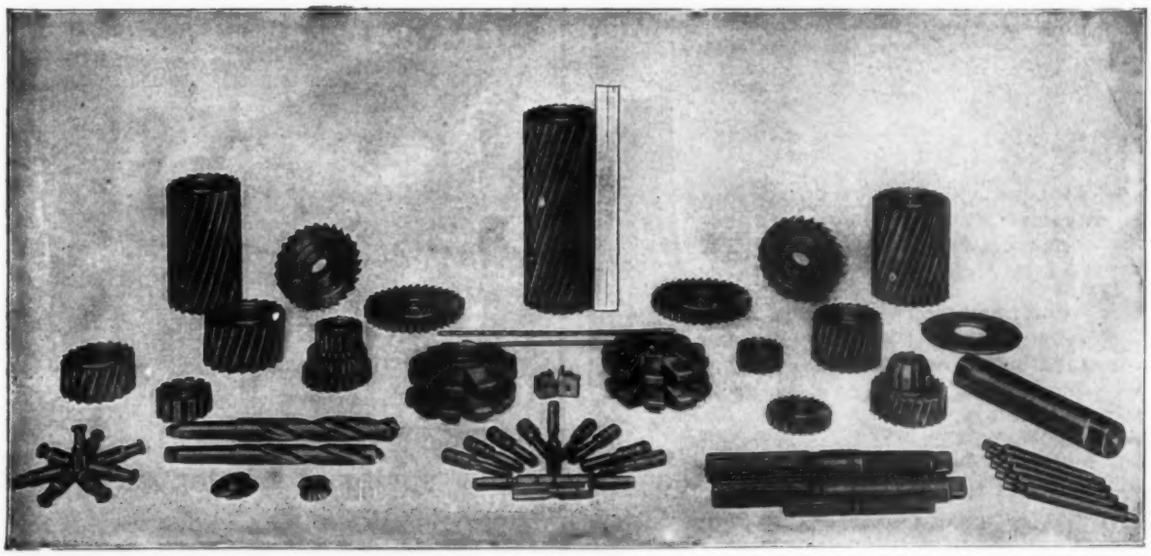

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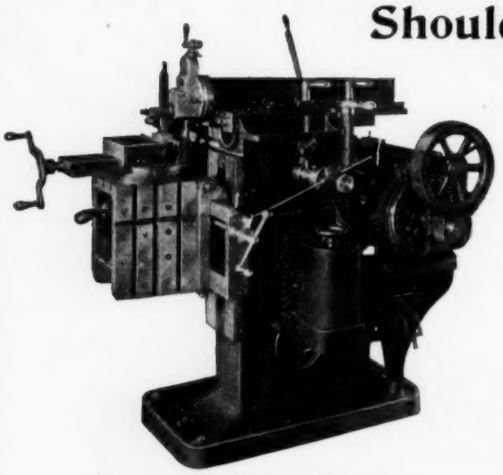
Should form a Unit.



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Motor and controller are not detached, but form, with the machine tool, a symmetrical, well proportioned unit.

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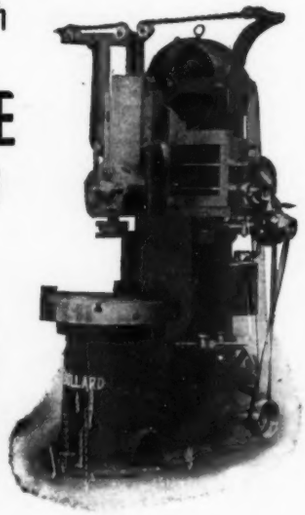

has met with, is not due to chance, but to the sterling merits of its design and construction.

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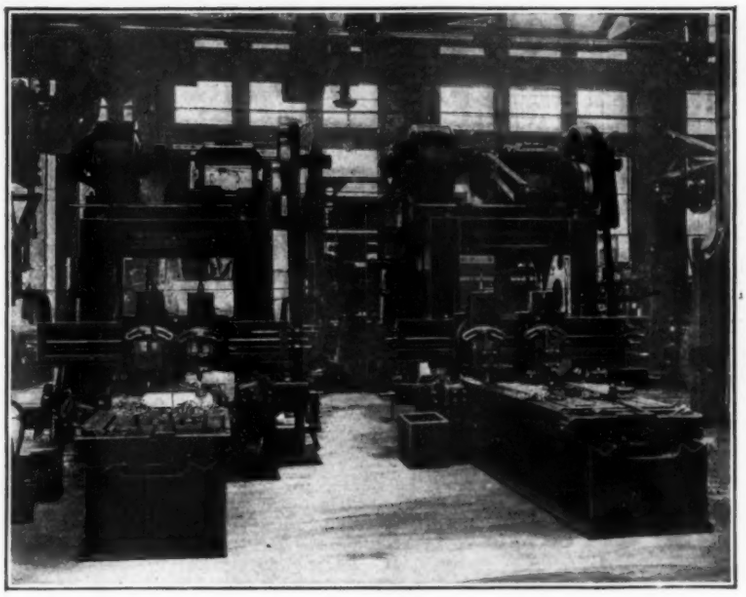

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Quality Tells

The quality of a motor has a direct bearing upon the quality of the product turned out by the machine which it drives. If you want quality in your product see that you get quality in your motors.

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Power savers—cost reducers
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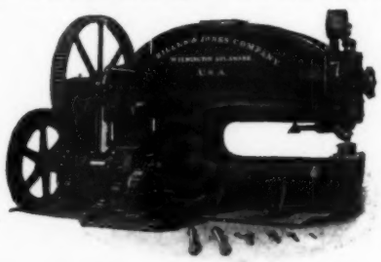

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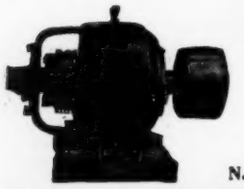

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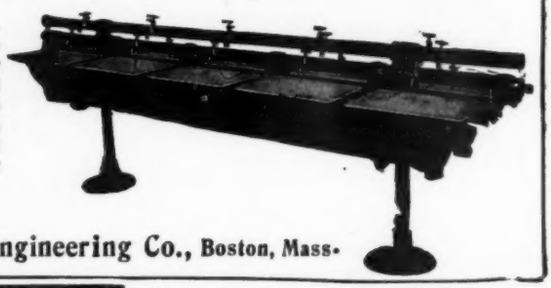

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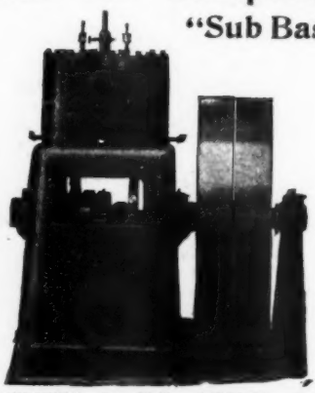

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Wide Range. Great Adaptability.
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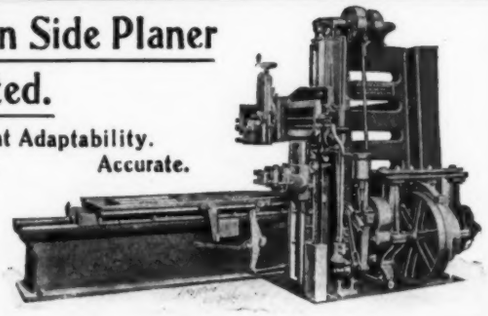

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For portable use in measuring the shaft speed of all classes of machinery. Very sensitive and accurate. Speed ranges from 30 to 4,000 r.p.m., and 200 to 24,000 r.p.m. Full particulars of our many types furnished upon application. Send for Catalog.

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LIGHTEST tools made :: ::
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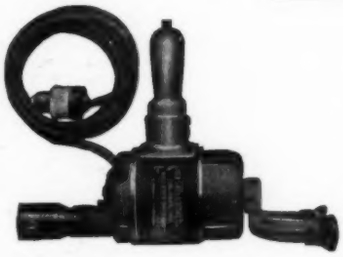
Will do hard work ten hours a day, then work overtime and not be a burden to the operator and still be cool.



These tools are complete in design, making them simple in construction.

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Chuck arranged for close corner or central drilling. :: ::

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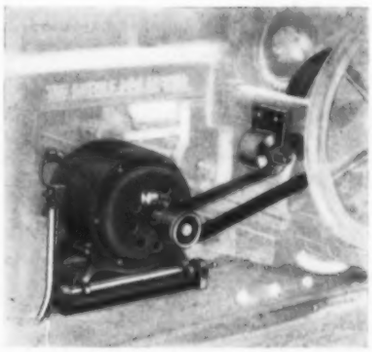

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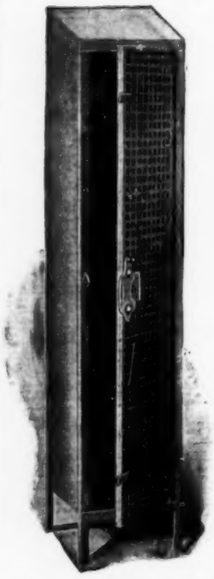

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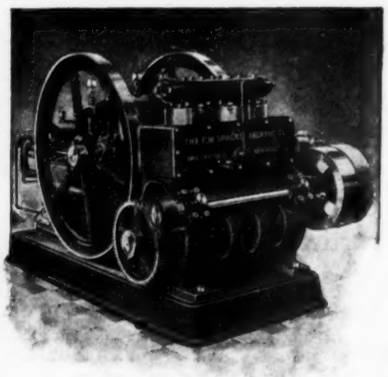

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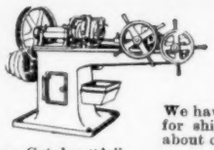

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are accurately cut and cut in almost no time, so it does'nt cost you much for keyseats if you have a Catlin about the place.

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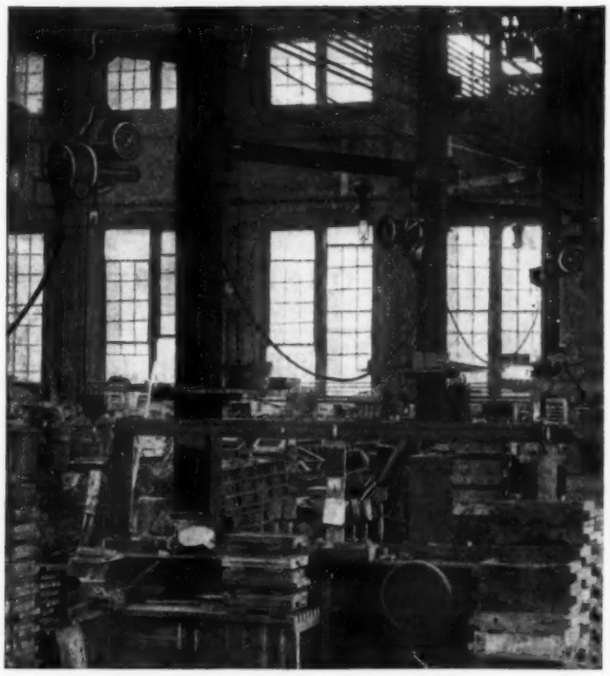

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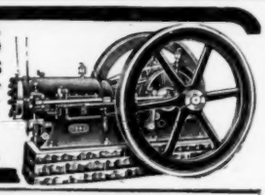
are strong where they ought to be. Ask for Cat. M.



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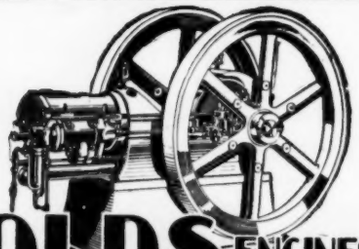

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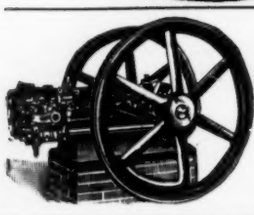

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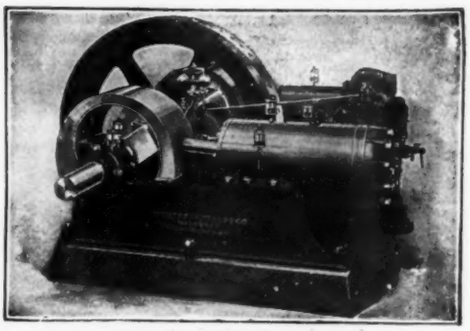

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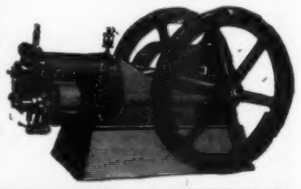

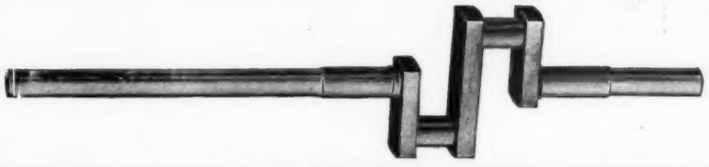

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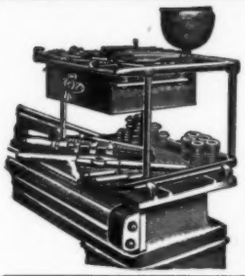

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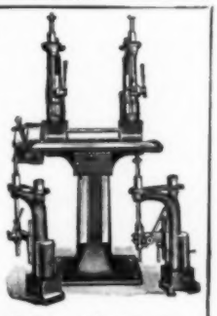

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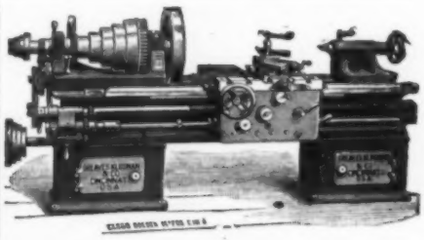

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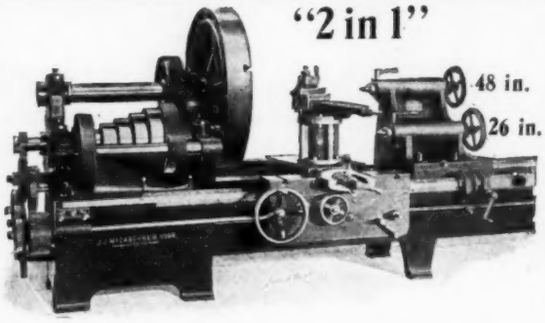

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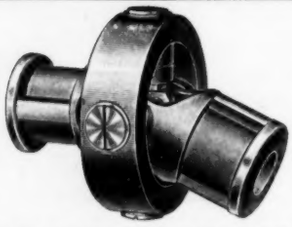

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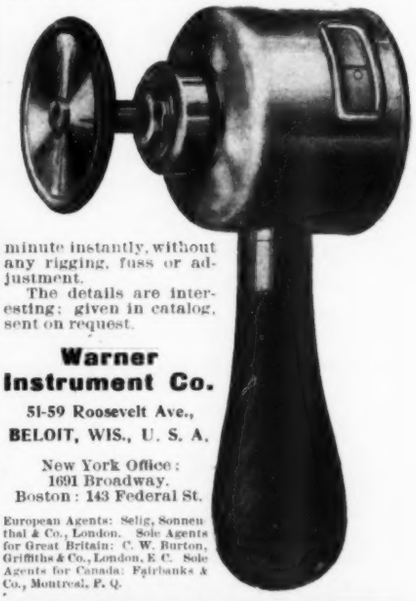

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INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
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CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U.S.

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Gears made to order.
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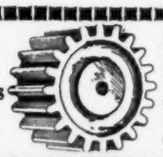
If you let me make your gears they'll be right.



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You will be surprised at the results obtained by using Nuttall Cut and Planed Gears. Put them on one of your machines and note the difference.

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Gears { of all *kinds* and *sizes* in stock and made to order.
From—the cheapest that's *good*
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Sample our Workmanship.
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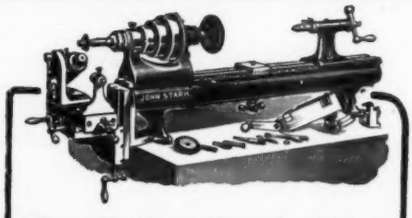

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The Stark No. 4 Bench Lathe, with milling attachment is unequalled.
Light, strong and accurate, it is the product of years of experience. Write for Catalog No. 29.

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for that new machine that Simonds is to cut the gears, and you'll have one less thing to worry about.

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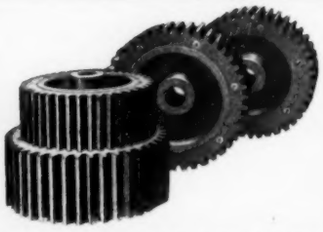

Fawcus Gears are carefully designed, made of highest grade material, by Fawcus patented machinery operated by skilled workmen.

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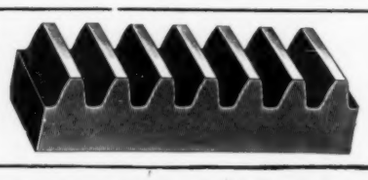
Investigate Our Rack. You Are to Blame if You Do Not Write Us for Catalogue and Prices.



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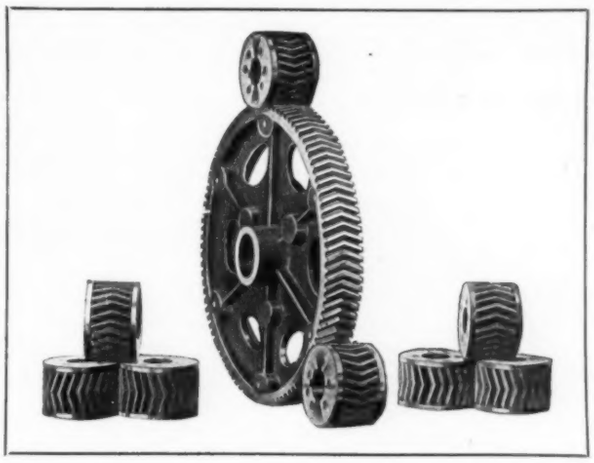

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ARE MADE IN ANY STYLE TO SUIT OUR CUSTOMERS.

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With or without legs.

Cuts ⅛ x 2 in. Flat ¼ to ¾ in. Round Punches ⅜ in. hole in ⅜ in. stock; ½ in. hole in ¼ in. stock.

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is something new in turret lathes. It will do either short or long work and can be easily and quickly changed from one to the other. It turns out work within an accuracy limit of + or — .00025" Ask for the particulars.

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A combination of common flat plier and gas plier. Made from the best hardened tool steel.

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See to it that our TRADE MARK

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Is stamped plainly on their face; all others are IMITATIONS.

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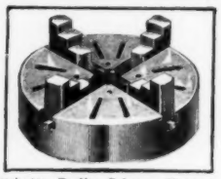

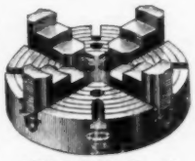

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MADE BY

Wm. G. LeCount,

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Ask for Catalog A, Machine Tools.

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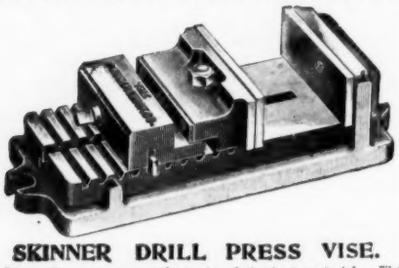

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These Vises are accurately made of the be t materials. The jaws are faced with steel. The nuts and screws are hardened. A forged steel wrench is furnished with each Vise. Ask for the price.

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THE PRATT CHUCK

will serve you well—first, last and all the time. Write for Book.

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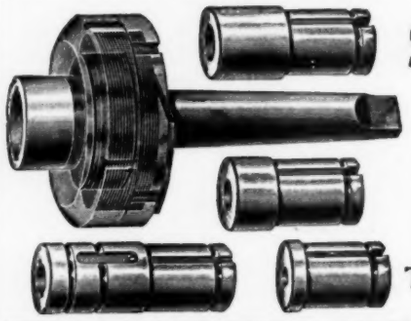

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Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction and is

UNEQUALED FOR

Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to *break* or get out of *order*. Made in 4 sizes, covering from 0 to 2½ in. diameter.

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Lathe Chucks, Drill Chucks and Face Plate Jaws. Catalog gives full description and is sent free.

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All the strength is in the right place

in Sweetland Chucks. Not one ounce of superfluous weight either. They have a reversible jaw equal to a solid jaw.

Particulars?

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THE standard set by Almond over a quarter of a century ago is not approached today in other makes of Drill Chucks

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from right is a great way wrong in Drill Chucks. THE REID CHUCK IS RIGHT.

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Chucks For Heavy Work

Whiton's Heavy Chucks are for use on modern turret lathes or wherever power and durability are essential. Work held by Whiton Chucks won't chatter or pull out—it can't. Catalog tells why.

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"The 20th Century Way"

"The Key To The Situation"

is the Toothed Key, which takes the place of the old-fashioned Spanner, and operates the JACOBS IMPROVED DRILL CHUCK. By means of this key a drill, tap or other tool is quickly and firmly secured—a turn of the hand does it. If you are doing it in the old way—wearing the belt, drill and chuck—wasting time, money and patience—you will certainly be interested in the new, or Jacobs, way. :: :: :: ::

Our chuck is fully guaranteed. Ask us more about it. :: :: :: :: ::

The Jacobs M'f'g Co., Hartford, Conn., U.S.A.

ERRINGTON
AUTO-REVERSE
TAPPING CHUCK.

No. 00 Taps to	3/16	Inch.	
No. 0	" "	1/4	"
No. 1	" "	3/8	"
No. 2	" "	1/2	"
No. 3	" "	1 1/4	"
No. 4	" "	1 1/2	"
No. 5	" "	2	"

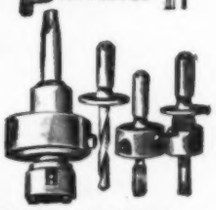
Fits any Drill Press.

Drills, Taps Sets Studs, In Line.

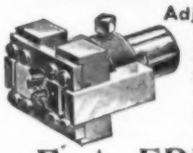
The Only Automatic Reverse.

NO { STOPPING, REVERSING, MOVING WORK, CHANGING SPEED.

Quick-Change Tool Holders.



OPENING DIE.



Adjustable

No.	Std.	Pipe.
1 Threads to	5/8 in.	3/4 in.
2 Threads to	1 in.	1 1/4 in.
3 Threads to	1 1/2 in.	1 in.
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Opens and Closes While Rotating.

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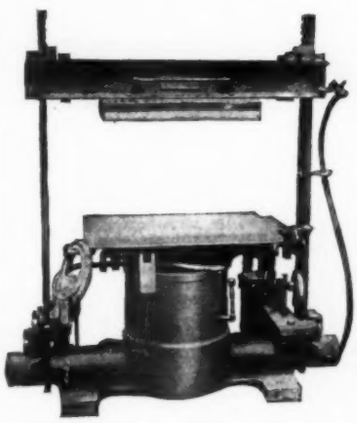
England: Chas. Churchill & Co., London, Birmingham, Glasgow, Manchester, Newcastle-on-Tyne. Switzerland: American Import Machinery Office, Zurich and Chaux-de-Fonds. Germany: Arthur Kayser, Berlin, S. W., Alte Jacobstrasse 24, France: Edgar Bloxham, 2 Rue du Delta, Ecuries, Paris.

Tabor Molding Machines Cost You Nothing.



13 x 36 Power Squeezer.

The use of unskilled labor on The Tabor Molding Machines, together with the increased production obtained, quickly offsets their original cost. Consequently they, in effect, cost you nothing, and soon increase your profits by decreasing your expenses.

Shall we send you the proof of this statement ?

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18th and Hamilton Streets,

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—Specify—

Patented in United States and Foreign Countries

The American

the first and only high grade STEEL PULLEY on the market. Built on scientific principles and fully guaranteed.

Sold by Supply Houses.

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Can't you see how grinding at this clip, good grinding, is going to increase the earning capacity of your grinding department?

The Besly Disc Grinder with Spiral Circles will grind any flat surface with greater accuracy and in 50% less time than any other method. We'll prove this, if you'll let us grind some of your unfinished samples, without expense to you.

Originators of Disc Grinders

CHARLES H. BESLY & CO.
15-17-19-21-S. CLINTON ST.
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For the Rapid Output of Precision Work

this new Model No. 8 Bench Lathe fulfills the demand. Inventors, model builders and fine tool makers recognize in it their ideal tool.

Headstock, bushings and spindles are made of tool steel.

It is built with extreme care in every detail and it contains many improvements which facilitate rapid, accurate production.

We will gladly send catalog.

American Watch Tool Co.,
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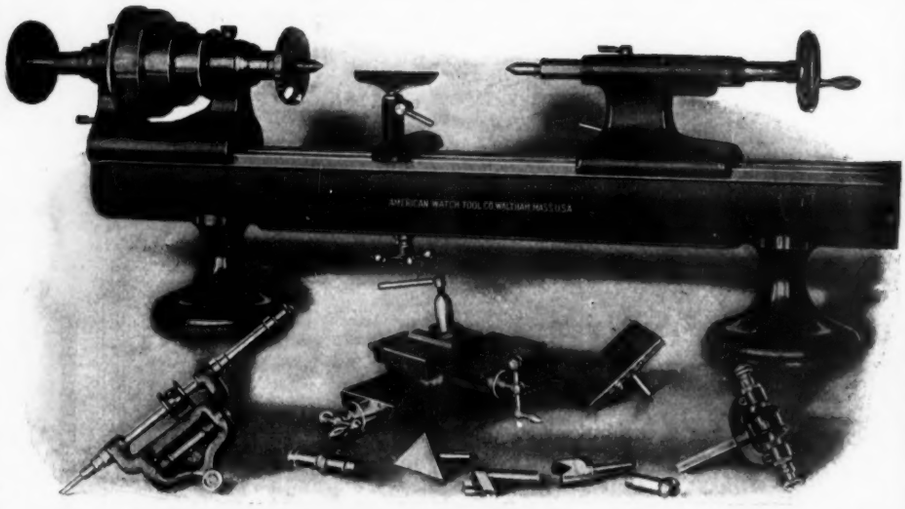
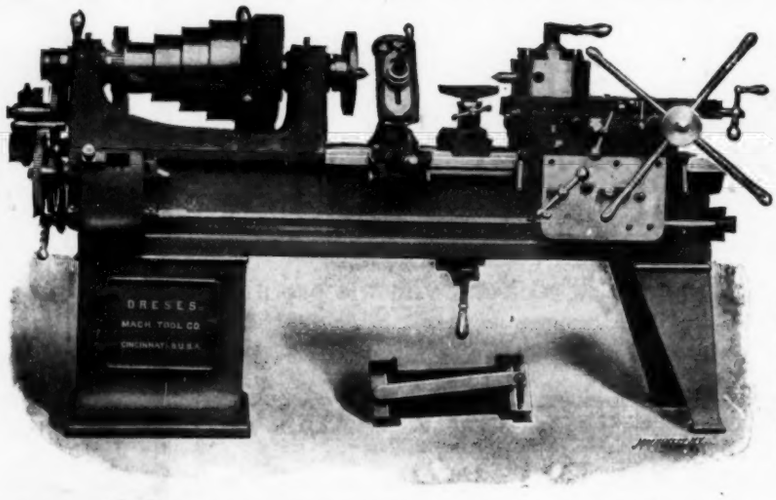


20' FULL UNIVERSAL MONITOR LATHE.

Designed with the object of manufacturing without special tools in a more economical way than is possible with an ordinary Monitor Lathe.



FOR GENERAL BRASS WORK,

and similar work of special heavy character it has no equal.

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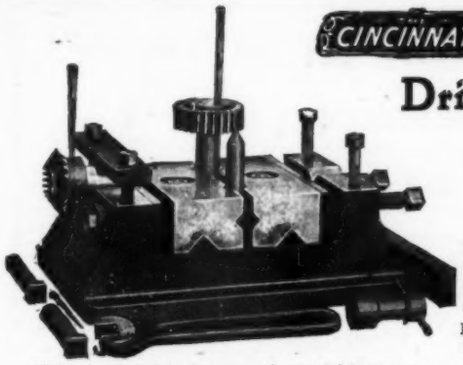

CINCINNATI

Drill Press Chuck.

The most convenient and useful chuck for drill press, milling machine, shaper and planer to be obtained.

This chuck holds flat, round, straight or taper work equally well and adjusts itself to the shape of the work holding it securely in the most practical manner.

The steel blocks used are planed from bar machinery steel and for different sizes of V's planed true and square at different angles as well as the body of the chuck which affords the best and most convenient way of holding work of various shapes.

The blocks may be easily removed by passing the heads of the clamping screws from the T slot in the body of the chuck at an opening provided for same which allows the blocks to be used as regular V blocks containing several sizes of V's or they may be used as parallel blocks.

The steel jaw attached to the body of the chuck may be removed by taking out the hexagon head screws which pass freely through threaded holes and the large set screws shown in cut inserted and used for holding rough work thereby keeping the jaws in good shape for better work.

The No. 3 Chuck is 6" wide, $1\frac{1}{16}$" deep, it will open 2" with both blocks in place, 4" with one block in place and 6" with both blocks removed.

Cincinnati Machine Tool Co.,
Western Avenue and Dayton Street,
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Cable Address; "AUGUSTUS," CINCINNATI.
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Prepare Now For Increased Profits Next Year

Consult us about your small parts. We will *prove* to you, at *our* expense, that Franklin Die Cast finished parts are both *cheaper* and *better* than machine made parts.

We will tell you, exactly, their cost to you—showing you your profits in advance.

If that is a fair proposition, send for our booklet, "Franklin Castings," and free samples.

A post card will do—but do it *now*.

H. H. Franklin Manufacturing Co.
200 So. Geddes St., Syracuse, N. Y., U. S. A.

GISHOLT

REG. U.S. PAT. OFF.

Duplicate Parts Finished To Advantage on Gisholt Lathes in Dozen Lots and Less.

In many instances we have been able to show a decided saving when parts are run through in comparatively small lots. It is not necessary to run parts thru in lots of one and two hundred. While, of course, the larger the number the greater the saving, yet the nature of the work has very largely to do with the question of economy in Gisholt Practice.

The thing to do is to have us figure on your parts. Let us make you a definite proposition on a machine and tool outfit and make you a time estimate. Then you will know what Gisholt Lathes will do for you.

Gisholt Machine Co.

WORKS:
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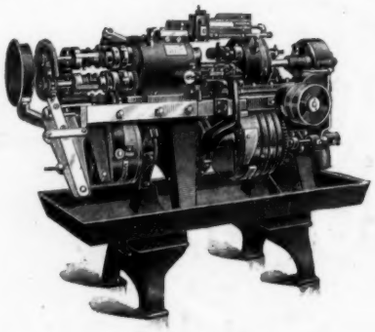
Foreign Agents—Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchart & Schutte, Vienna, St. Petersburg, Stockholm, Berlin. C. W. Burton, Griffiths & Co., England.

Don't YOU worry about your competitor, get an "Acme" Automatic Screw Machine.



He will start to worry then. He'll wonder how you can turn out work so cheaply. Meantime, your "Acme" Automatic will be acting upon four bars or rods simultaneously up to eight operations, in the time of one, and with only one set of tools. The spindles are gear driven with no belts to pull on them. Cams act in both directions with no springs for reverse motion. Swing into the line—get the catalog.

The National-Acme Manufacturing Co.

BRANCH OFFICES—New York, Chicago. **Cleveland, Ohio, U. S. A.**

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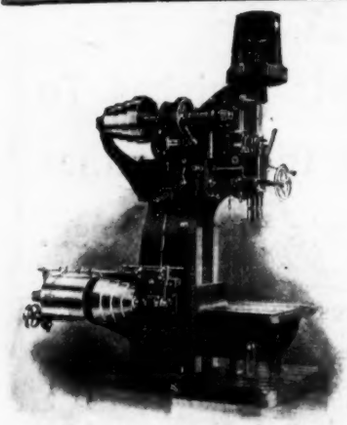

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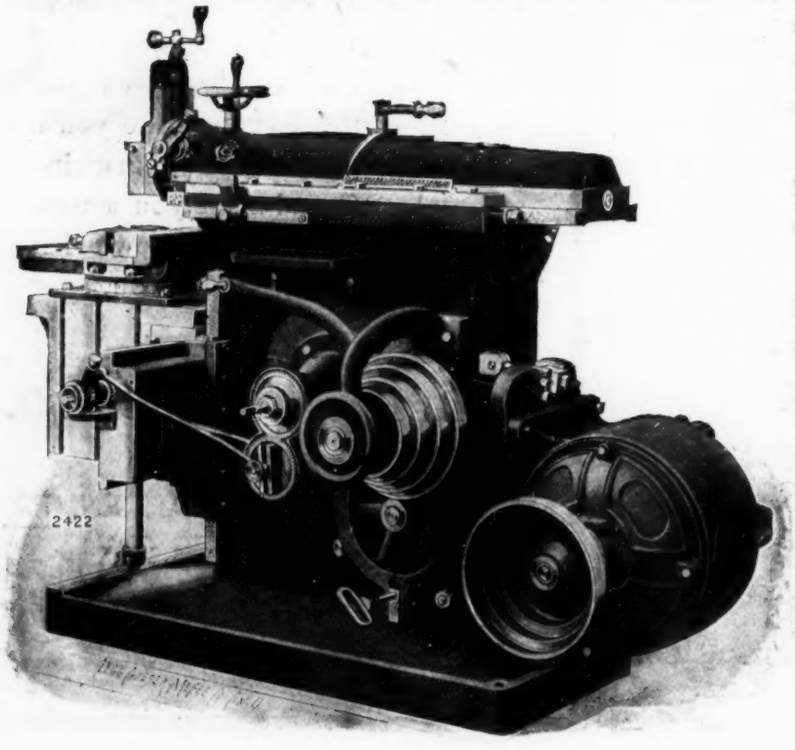

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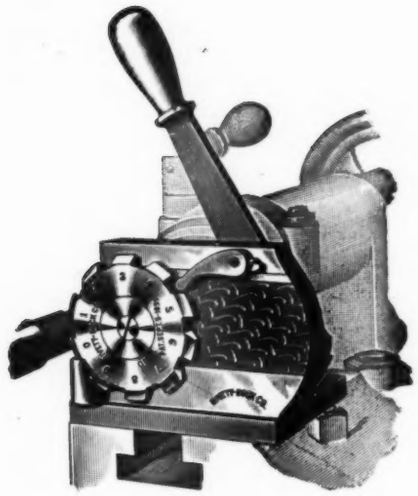

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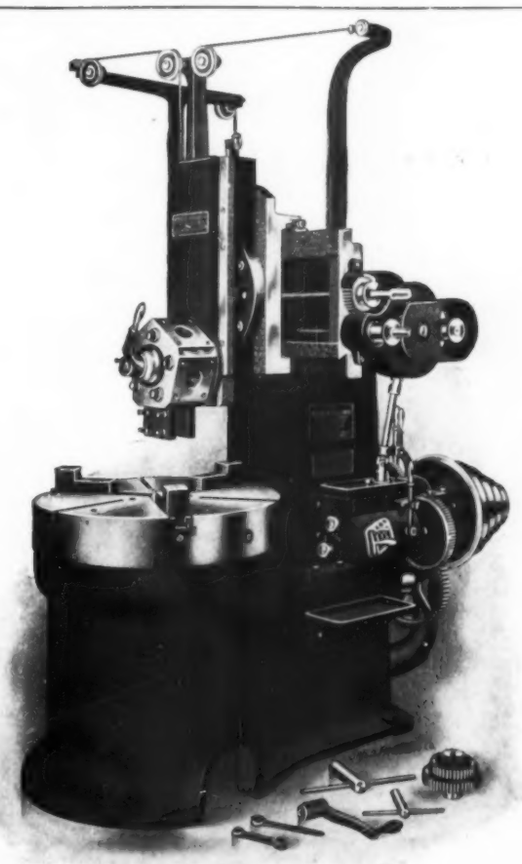

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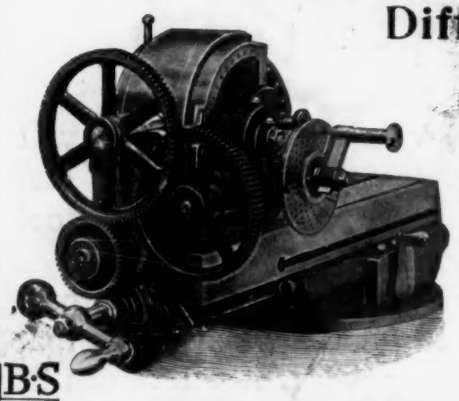

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